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March 1989

Final Report

Final Report of A Flat Frontal Barrier Impact of A Ford Mustang Containing A Retrofit Driver's Airbag System

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J.W. Sankey, Supervisor, Laboratory Engineering, TRC	890216
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15. Supplementary Notes

This test was conducted as a part of Project VRTC-87-0078: Seat belt/Airbag Phasing Study.

16. Abstract

A 30 mph flat frontal barrier impact test was conducted on a 1986 Ford Mustang 3-door hatchback, VIN 1FABP28M7GF239937, at the Transportation Research Center of Ohio on February 16, 1989. A Retrofit driver's airbag system was installed in the vehicle prior to the impact test.

The barrier impact velocity was 30.1 mph.
The ambient temperature was 70° F

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TABLE OF CONTENTS

SECTION	DESCRIPTION	PAGE
1.0	PURPOSE AND TEST SUMMARY	1-1
2.0	SUMMARY OF RESULTS	2-1
3.0	CAMERA INFORMATION	3-1
APPENDIX A	PHOTOGRAPHS	A-1
APPENDIX B	DATA PLOTS	B-1
APPENDIX C	DUMMY CALIBRATION INFORMATION	C-1
APPENDIX D	MISCELLANEOUS TEST INFORMATION	D-1

LIST OF TABLES

NUMBER	DESCRIPTION	PAGE
1	CRASH TEST SUMMARY	1-5
2	TEST VEHICLE INFORMATION	1-6
3	TEST CONDITIONS	1-10
4	VEHICLE ACCELEROMETER LOCATIONS AND DATA SUMMARY	1-13
5	IMPACTED VEHICLE MEASUREMENTS	1-17
6	DUMMY DATA SUMMARY	2-2
7	HIGH SPEED CAMERA LOCATIONS	3-3

LIST OF FIGURES

NUMBER	DESCRIPTION	PAGE
1	IMPACT VELOCITY MEASUREMENT SYSTEM	1-11
2	VEHICLE ACCELEROMETER PLACEMENT	1-12
3	VEHICLE CRUSH	1-14
4	PRE-TEST AND POST-TEST MEASUREMENT POINTS	1-15
5	DUMMY POSITIONING DATA	2-5
6	DUMMY IN-VEHICLE POSITION RECORDING SHEET	2-6
7	DRIVER DUMMY TO STEERING COLUMN ASSEMBLY REFERENCE DIMENSIONS	2-7
8	CAMERA POSITIONS	3-2

LIST OF PHOTOGRAPHS

DESCRIPTION	FIGURE
PRE-TEST FRONT VIEW	A-1
POST-TEST FRONT VIEW	A-2
PRE-TEST LEFT SIDE VIEW	A-3
POST-TEST LEFT SIDE VIEW	A-4
PRE-TEST RIGHT SIDE VIEW	A-5
POST-TEST RIGHT SIDE VIEW	A-6
PRE-TEST RIGHT FRONT THREE-QUARTER VIEW	A-7
POST-TEST RIGHT FRONT THREE-QUARTER VIEW	A-8
PRE-TEST LEFT REAR THREE-QUARTER VIEW	A-9
POST-TEST LEFT REAR THREE-QUARTER VIEW	A-10
PRE-TEST REAR VIEW	A-11
POST-TEST REAR VIEW	A-12
PRE-TEST ENGINE COMPARTMENT VIEW	A-13
POST-TEST ENGINE COMPARTMENT VIEW	A-14
PRE-TEST FRONT UNDERBODY VIEW	A-15
POST-TEST FRONT UNDERBODY VIEW	A-16
PRE-TEST DRIVER DUMMY POSITION VIEW	A-17
POST-TEST DRIVER DUMMY POSITION VIEW	A-18
PRE-TEST DRIVER DUMMY & VEHICLE INTERIOR - VIEW 1	A-19
POST-TEST DRIVER DUMMY & VEHICLE INTERIOR - VIEW 1	A-20
PRE-TEST DRIVER DUMMY & VEHICLE INTERIOR - VIEW 2	A-21
POST-TEST DRIVER DUMMY & VEHICLE INTERIOR - VIEW 2	A-22
POST-TEST DRIVER DUMMY HEAD CONTACT	A-23
PRE-TEST DRIVER DUMMY KNEE BLOCKER MODIFICATION	A-24
POST-TEST DRIVER DUMMY KNEE CONTACT	A-25

SECTION 1.0

PURPOSE AND TEST SUMMARY

PURPOSE

This 30 mph frontal barrier impact test was conducted as a part of the Seat Belt/Airbag Phasing Study, VRTC Project Number VRTC-87-0078. The purpose of this test was to determine the performance of a Romeo retrofit driver's airbag system in the subject vehicle, a 1986 Ford Mustang GT 3-door hatchback.

TEST SUMMARY

The 1986 Ford Mustang GT 3-door hatchback was equipped with a 5.0 liter, inline V-8 engine, manual transmission, power steering, and power brakes. The test weight of the vehicle was 3553 pounds. The Head Injury Criteria (HIC) calculation was 571.5, the resultant acceleration of the thorax was 47.7 g's, and the compressive forces transmitted through the right and left femurs were 1035.1 pounds and 1505.3 pounds, respectively.

One Part 572 B, 50th percentile, adult male anthropomorphic test device (ATD) was seated in the left front outboard designated seating position. The dummy was positioned according to the dummy placement procedures specified in NHTSA's Notice 46 of the Federal Motor Vehicle Safety Standard No. 208.

The ATD was instrumented with head and chest accelerometers oriented to measure accelerations in the longitudinal, lateral, and vertical directions, and with right and left femur load cells.

The vehicle was instrumented with five (5) accelerometers oriented to measure longitudinal axis acceleration.

The crash event was recorded by one (1) real-time panning camera, seven (7) high-speed motion picture cameras operating at approximately 1,000 frames per second, and one (1) high-speed motion picture camera operating at approximately 3,000 frames per second.

The thirteen (13) channels of data were multiplexed and recorded on a 14-track tape drive. The data was digitally sampled at 8,000 samples per second and digitally processed per sections 12.8 and 12.9 of Laboratory Procedure TP-208-07.

The vehicle was impacted into the rigid, flat frontal barrier at the Transportation Research Center of Ohio on February 16, 1989. The test vehicle's impact speed was 30.1 mph. The vehicle sustained 12.0 inches of static crush.

The camera information is presented in Section 3.0. Appendix A contains the still photographic prints. Appendix B contains the vehicle and dummy data plots. Appendix C contains the dummy calibration information. Appendix D contains miscellaneous test information.

TABLE 1 CRASH TEST SUMMARY

PROJECT: Seat Belt/Airbag Phasing Study DATE: 2/16/89

VEHICLE: Ford Mustang GT TIME: 1041 TEMP: 70° F

VEHICLE TEST WEIGHT (LBS): 3553

IMPACT ANGLE (DEG)*: 0

IMPACT VELOCITY (MPH)**: PRIMARY = 30.1 SECONDARY = 30.1

MAXIMUM STATIC CRUSH (IN): 12.0

VEHICLE REBOUND (IN): 1.5

DUMMIES: Driver #830

TYPE: Part 572 B

LOCATION: Left Front

RESTRAINT: Romeo Retrofit Driver's Airbag System

NUMBER OF DATA CHANNELS: 13

NUMBER OF CAMERAS: HIGH-SPEED 8 REAL-TIME 1

*With respect to tow track centerline.
**Speed trap measurement (± .05 mph accuracy)

TABLE 2 TEST VEHICLE INFORMATION

VEHICLE MANUFACTURER: Ford Motor Company MAKE/MODEL: Ford Mustang GT

VIN: 1FABP28M7GF239937 BODY STYLE: 3-door hatchback

MODEL YEAR: 1986 COLOR: Silver

ENGINE DATA: TYPE: inline V-8 CYLINDERS: 8 DISPLACEMENT: 5.0 liter

TRANSMISSION DATA: _5_ SPEED, _X_ MANUAL, ___ AUTOMATIC, ___ FWD, _X_ RWD, ___ 4WD

DATE VEHICLE RECEIVED: 2/07/89 ODOMETER READING: 44,903.0

DEALER'S NAME AND ADDRESS: NA

ACCESSORIES:

POWER STEERING Yes	AUTOMATIC TRANSMISSION No
POWER BRAKES Yes	AUTOMATIC SPEED CONTROL Yes
POWER SEATS No	TILTING STEERING WHEEL Yes
POWER WINDOWS Yes	TELESCOPING STEERING WHEEL No
TINTED GLASS Yes	AIR CONDITIONING Yes
RADIO No	ANTI-SKID BRAKE No
CLOCK Yes	REAR WINDOW DEFROSTER Yes
OTHER None	

REMARKS:

1. IS THE VEHICLE STOCK THROUGHOUT? No*
2. DOES VEHICLE SHOW EVIDENCE OF PRIOR ACCIDENT HISTORY? No
3. DOES VEHICLE SHOW ANY SIGNIFICANT CORROSION? No
4. CONDITION OF THE FRONT/REAR BUMPER AND FRAME: Good

DATA FROM CERTIFICATION LABEL ON LEFT DOOR FACE OR "B" POST:

VEHICLE MANUFACTURED BY: Ford Motor Company

DATE OF MANUFACTURE: 4/86

GVWR: 4075 LBS.

GAWR: FRONT 2206 LBS., REAR 1996 LBS.

*Vehicle was modified to include a Romeo Retrofit driver's airbag system.

TABLE 2 TEST VEHICLE INFORMATION CONTINUED

WEIGHT OF TEST VEHICLE AS RECEIVED FROM DEALER (WITH MAXIMUM FLUIDS):

RIGHT FRONT	911 LBS.	RIGHT REAR	637 LBS.
LEFT FRONT	958 LBS.	LEFT REAR	620 LBS.
TOTAL FRONT WEIGHT	1869 LBS.	(59.8% OF TOTAL VEHICLE WEIGHT)	
TOTAL REAR WEIGHT	1257 LBS.	(40.2% OF TOTAL VEHICLE WEIGHT)	

TOTAL DELIVERED WEIGHT: 3126 LBS.

VEHICLE ATTITUDE (ALL DIMENSIONS IN INCHES:

DELIVERED ATTITUDE:	LF	27.2	;RF	27.2	;LR	27.8	;RR	27.8
PRE-TEST ATTITUDE:	LF	27.1	;RF	27.1	;LR	26.6	;RR	26.6
POST-TEST ATTITUDE:	LF	26.8	;RF	30.0	;LR	25.2	;RR	26.7

WHEELBASE: 100.8 INCHES

MAX. WIDTH: 69.2 INCHES

CG = 44.9 INCHES REARWARD OF FRONT WHEEL CENTERLINE

WEIGHT OF TEST VEHICLE WITH REQUIRED DUMMIES AND 99 LBS. OF CARGO:

RIGHT FRONT	959 LBS.	RIGHT REAR	805 LBS.
LEFT FRONT	1011 LBS.	LEFT REAR	778 LBS.
TOTAL FRONT WEIGHT	1970 LBS.	(55.4% OF TOTAL VEHICLE WEIGHT)	
TOTAL REAR WEIGHT	1583 LBS.	(44.6% OF TOTAL VEHICLE WEIGHT)	
TOTAL TEST WEIGHT	3553 LBS.		

WEIGHT OF BALLAST SECURED IN VEHICLE: 90 lbs. behind passenger's seat
50 lbs. behind driver's seat

COMPONENTS REMOVED TO MEET TARGET WEIGHT: None

TABLE 2 TEST VEHICLE INFORMATION CONTINUED

VEHICLE TIRE DATA:

RECOMMENDED COLD TIRE PRESSURE: 35 psi

TIRES ON VEHICLE (MFR., LINE, SIZE): Starfire Radial GV 235/60SR15

BIAS PLY, BELTED, OR RADIAL: Radial

SIDEWALL PLY RATING: 2 PLY

IS SPARE TIRE A "SPACE SAVER": Yes

IS SPARE TIRE STANDARD EQUIPMENT: Yes

DATA FROM "RECOMMENDED TIRE PRESSURE" LABEL ON DOOR, POST, GLOVEBOX, ETC.:

VEHICLE LOAD (UP TO CAPACITY): FRONT 35 psi; REAR 35 psi

RECOMMENDED TIRE SIZE: 225/60VR15 LOAD RANGE __X__B,_____C,_____D

VEHICLE CAPACITY DATA: TYPES OF SEATS: FRONT - Buckets
REAR - Buckets

NUMBER OF OCCUPANTS (DESIGNATED SEATING CAPACITY): __2__FRONT
__2__REAR
__4__TOTAL

CARGO LOAD__100__LBS.

TOTAL__700__LBS.

TABLE 2 TEST VEHICLE INFORMATION CONTINUED

TEST FLUID DATA

TEST FLUID TYPE: PURPLE STODDARD SOLVENT #2; SPEC. GRAVITY: 0.764

KINEMATIC VISCOSITY: 0.99 CENTISTOKES

"USEABLE" CAPACITY*: NA GALLONS

TEST VOLUME: 0.0 GALLONS (92-94% OF USEABLE)

FUEL SYSTEM CAPACITY (DATA FROM OWNERS MANUAL): NA GALLONS

DETAILS OF FUEL SYSTEM: NA

ELECTRIC FUEL PUMP: NA FUEL INJECTION: NA

DOES ELECTRIC FUEL PUMP OPERATE WITH IGNITION SWITCH "ON" AND THE ENGINE NOT OPERATING? NA

VEHICLE REBOUND AND CRUSH (ALL DIMENSIONS IN INCHES):

OVERALL LENGTH OF TEST VEHICLE:	PRE-TEST:	L	175.0;	C	176.6;	R 175.1
	POST-TEST:	L	163.0;	C	165.0;	R 165.0
	TOTAL CRUSH:	L	12.0;	C	11.6;	R 10.1

FOR FRONTAL IMPACTS, DISTANCE FROM FRONT OF TEST VEHICLE TO BARRIER AFTER IMPACT: L: 2.8; C: 1.8; R: 0.0; AVG: 1.5

*WITH ENTIRE FUEL SYSTEM FILLED.

TABLE 3 TEST CONDITIONS

TEST NUMBER: 890216

DATE OF TEST: 2/16/89 TIME OF TEST: 1041

WIND VELOCITY: 3-4 mph @ 342° NW HUMIDITY: NA

AMBIENT TEMPERATURE AT IMPACT AREA: 70° F

TEMPERATURE IN OCCUPANT COMPARTMENT: 68° F

DRIVER DUMMY TEMPERATURE: 71° F

PASSENGER DUMMY TEMPERATURE: NA

SUBJECT VEHICLE DATA

	ACTUAL	INTENDED
TEST WEIGHT (lbs.)	3553	3554
VEHICLE ORIENTATION (deg.)	0	0
VEHICLE VELOCITY (mph)	30.1	30.0
MAXIMUM CRUSH (in.): STATIC:	12.0	

DUMMIES

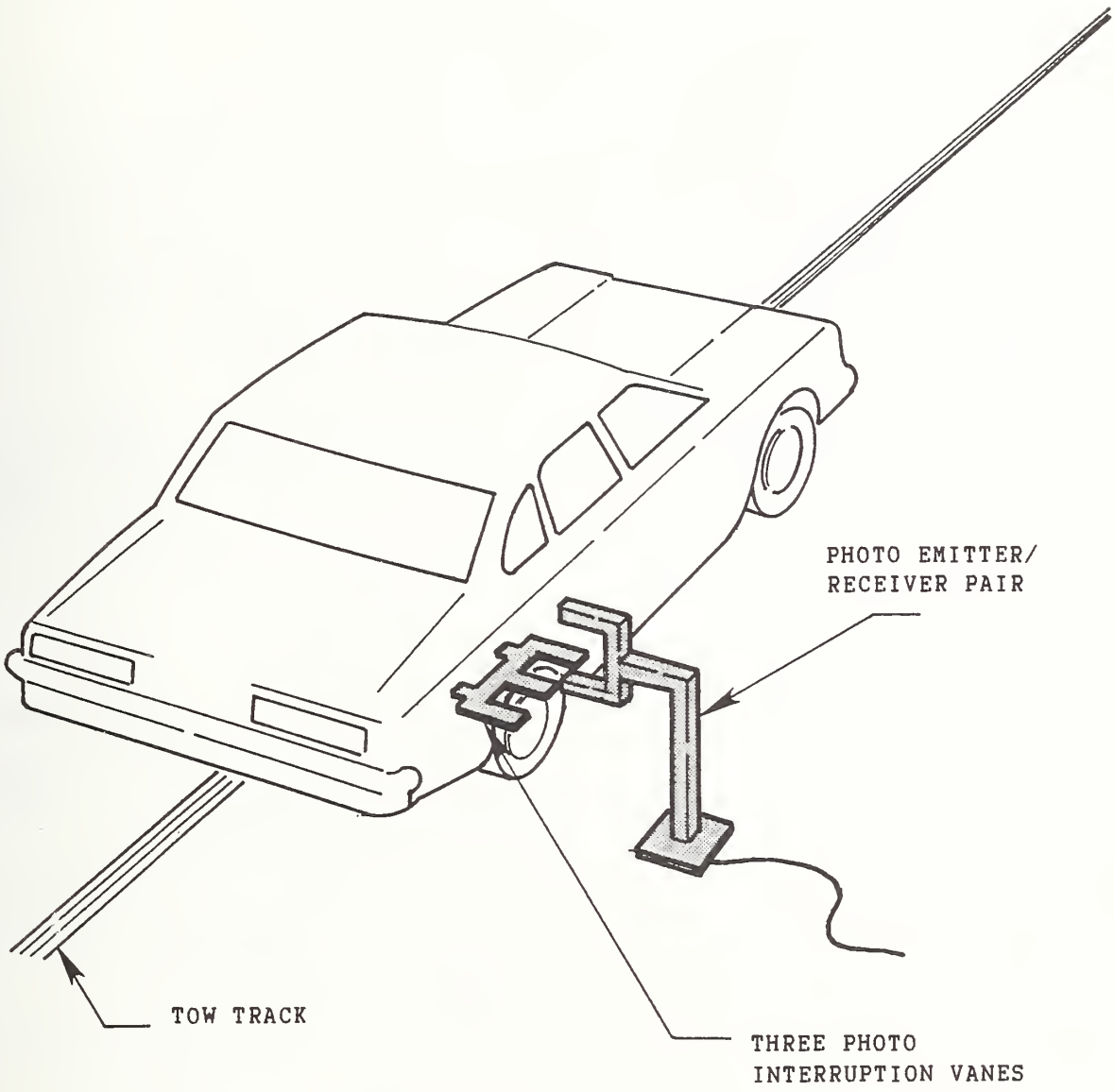
DRIVER

TYPE: Part 572 B
SERIAL NO.: 830
INSTRUMENTATION:
HEAD ACCEL.: 3
CHEST ACCEL.: 3
FEMUR L.C.'S: 2
OTHER:

RESTRAINT SYSTEM: Romeo Retrofit Driver's Airbag System

REMARKS:

FIGURE 1 IMPACT VELOCITY MEASUREMENT SYSTEM

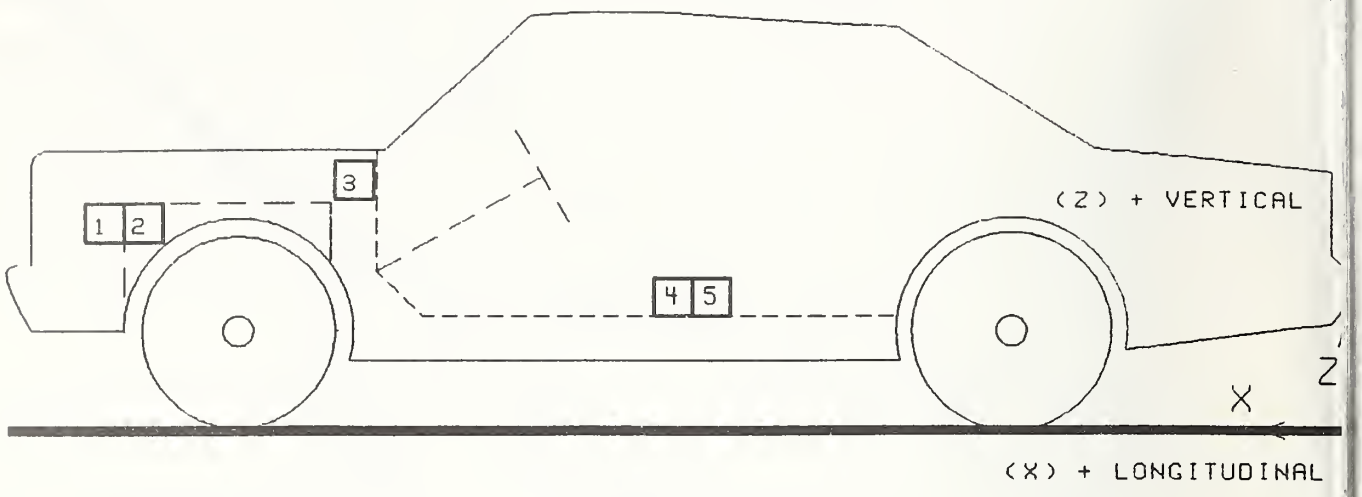


The final vane clears emitter/receiver two inches before impact.

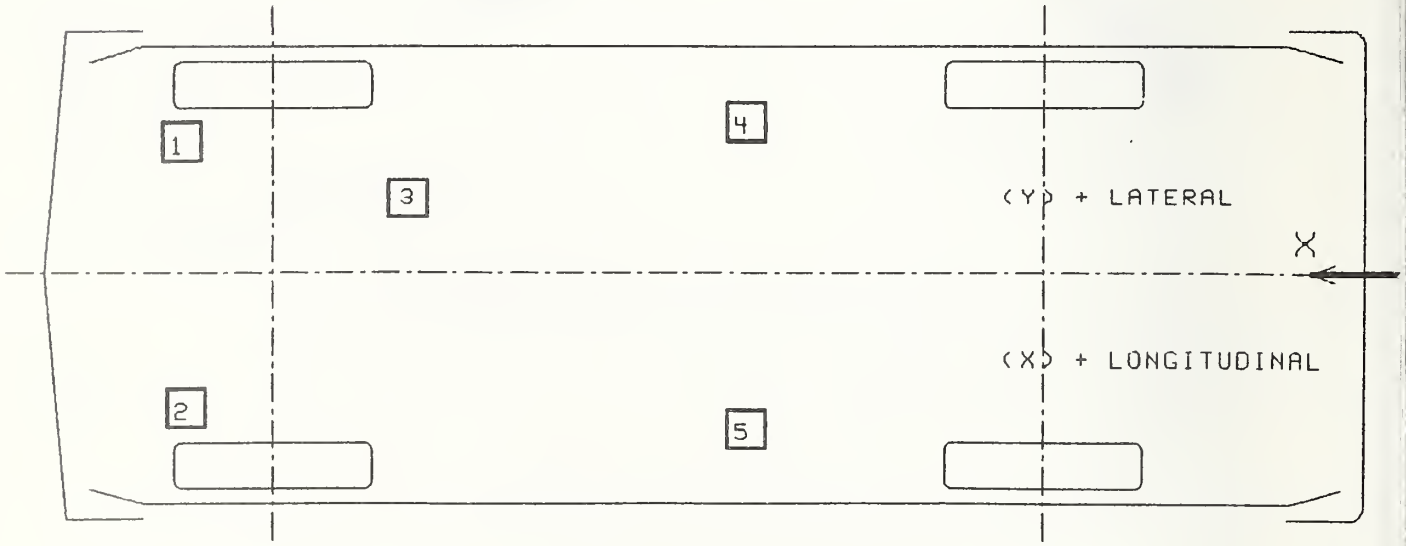
The vanes have one foot spacing.

FIGURE 2

VEHICLE ACCELEROMETER PLACEMENT



SIDE VIEW



BOTTOM VIEW

TABLE 4

TEST NUMBER 890216

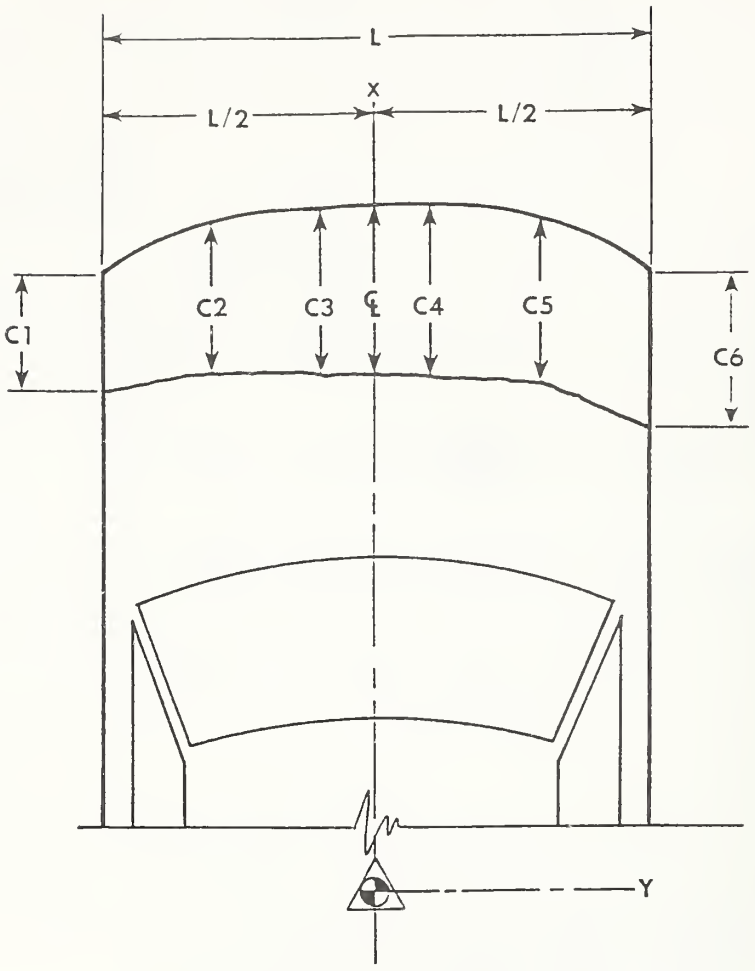
VEHICLE ACCELEROMETER LOCATIONS AND DATA SUMMARY

No.	LOCATION	X*	Y*	Z*	POSITIVE DIRECTION MAX G	POSITIVE DIRECTION MSEC	NEGATIVE DIRECTION MAX G	NEGATIVE DIRECTION MSEC
1	LEFT FRAME RAIL LONGITUDINAL	151.7	16.4	21.4	74.6	32.1	176.2	21.3
2	RIGHT FRAME RAIL LONGITUDINAL	153.2	-18.8	22.0	47.9	52.8	110.0	11.0
3	FIREWALL LONGITUDINAL	125.0	8.8	35.1	5.0	42.5	70.2	51.9
4	LEFT B-PILLAR LONGITUDINAL	66.9	27.6	14.4	1.6	151.6	35.7	56.8
5	RIGHT B-PILLAR LONGITUDINAL	66.8	-27.6	15.1	1.5	171.5	38.7	56.0

* ALL MEASUREMENTS OF ACCELEROMETER LOCATIONS ARE IN INCHES.

REFERENCE: X: + FORWARD FROM REAR BUMPER
Y: + LEFTWARD FROM VEHICLE CENTERLINE
Z: + UPWARD FROM GROUND LEVEL

FIGURE 3 VEHICLE CRUSH



NOTES: L is pre-test length of contact surface.
C1 through C6 are spaced equally apart.
CL is vehicle centerline.
All measurements are in inches.

Vehicle Ford Mustang

	PRE-TEST		POST-TEST		CRUSH
L	57.6				
C1	175.0	C1	163.0	C1	12.0
C2	175.2	C2	164.6	C2	10.6
C3	176.2	C3	165.2	C3	11.0
C4	176.2	C4	165.2	C4	11.0
C5	175.2	C5	164.2	C5	11.0
C6	175.1	C6	165.0	C6	10.1
CL	176.6	CL	165.0	CL	11.6

FIGURE 4

PRE-TEST AND POST-TEST MEASUREMENT POINTS

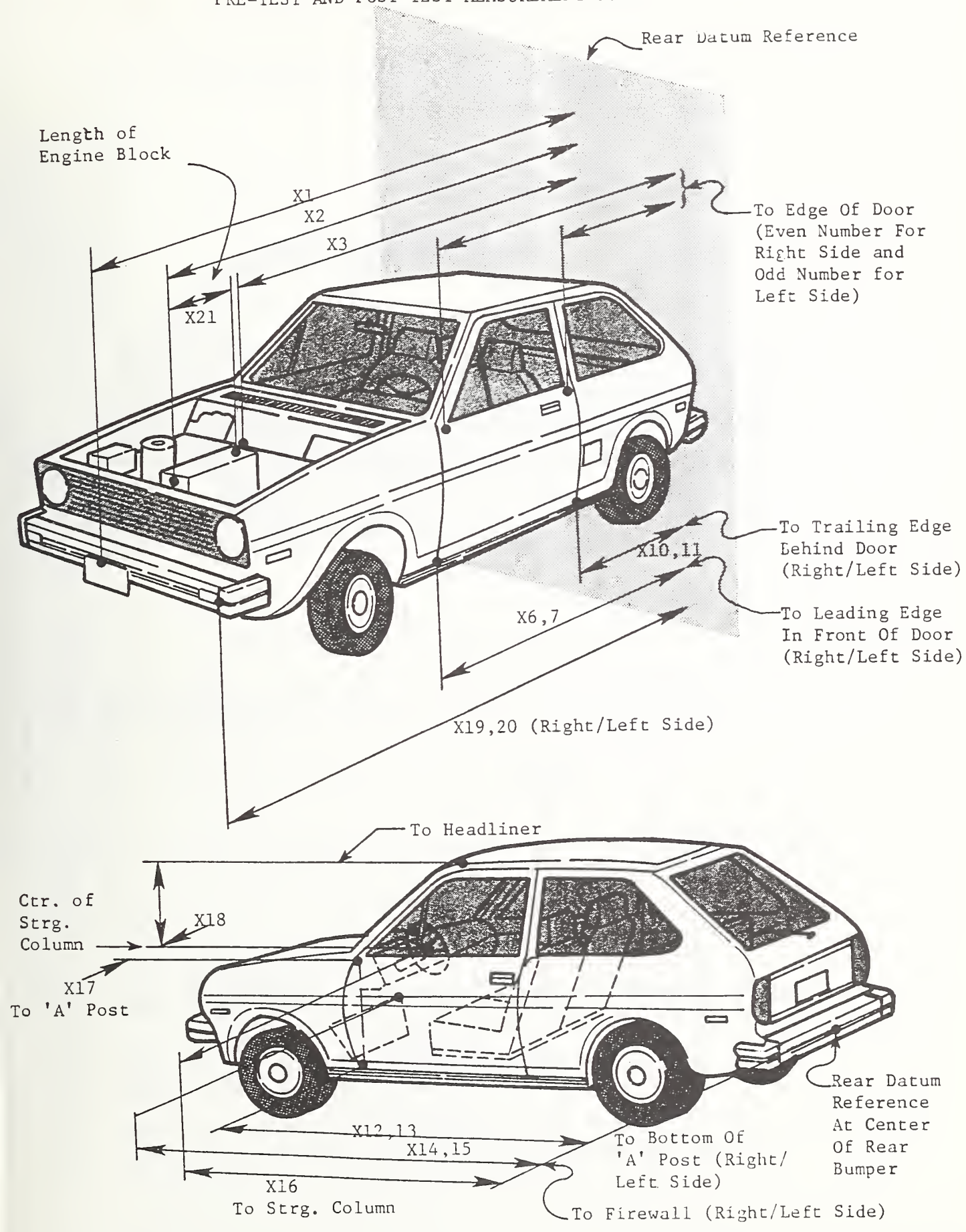
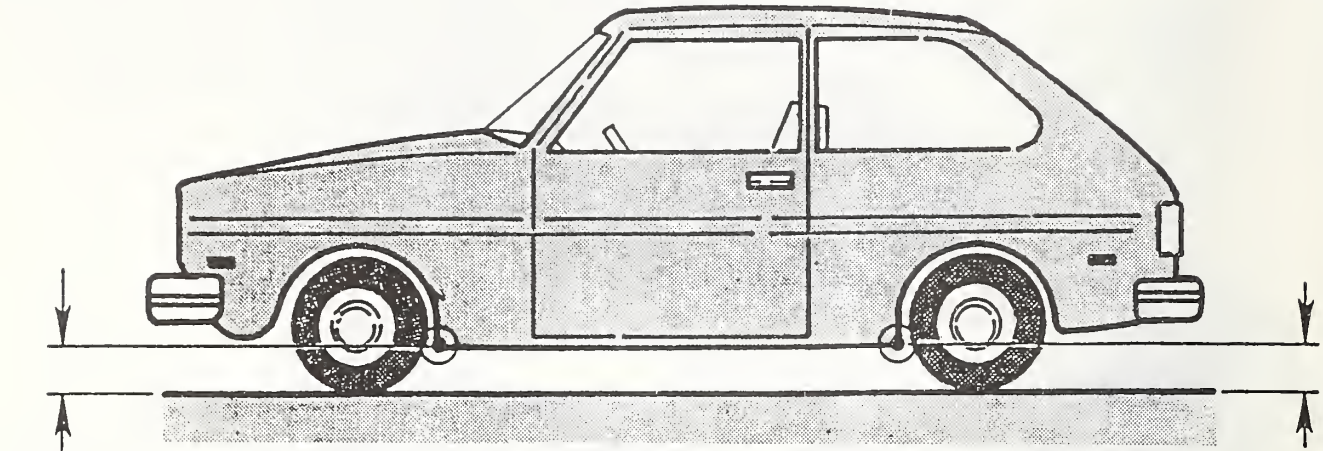


FIGURE 4

PRE-TEST AND POST-TEST MEASUREMENT POINTS CONTD.



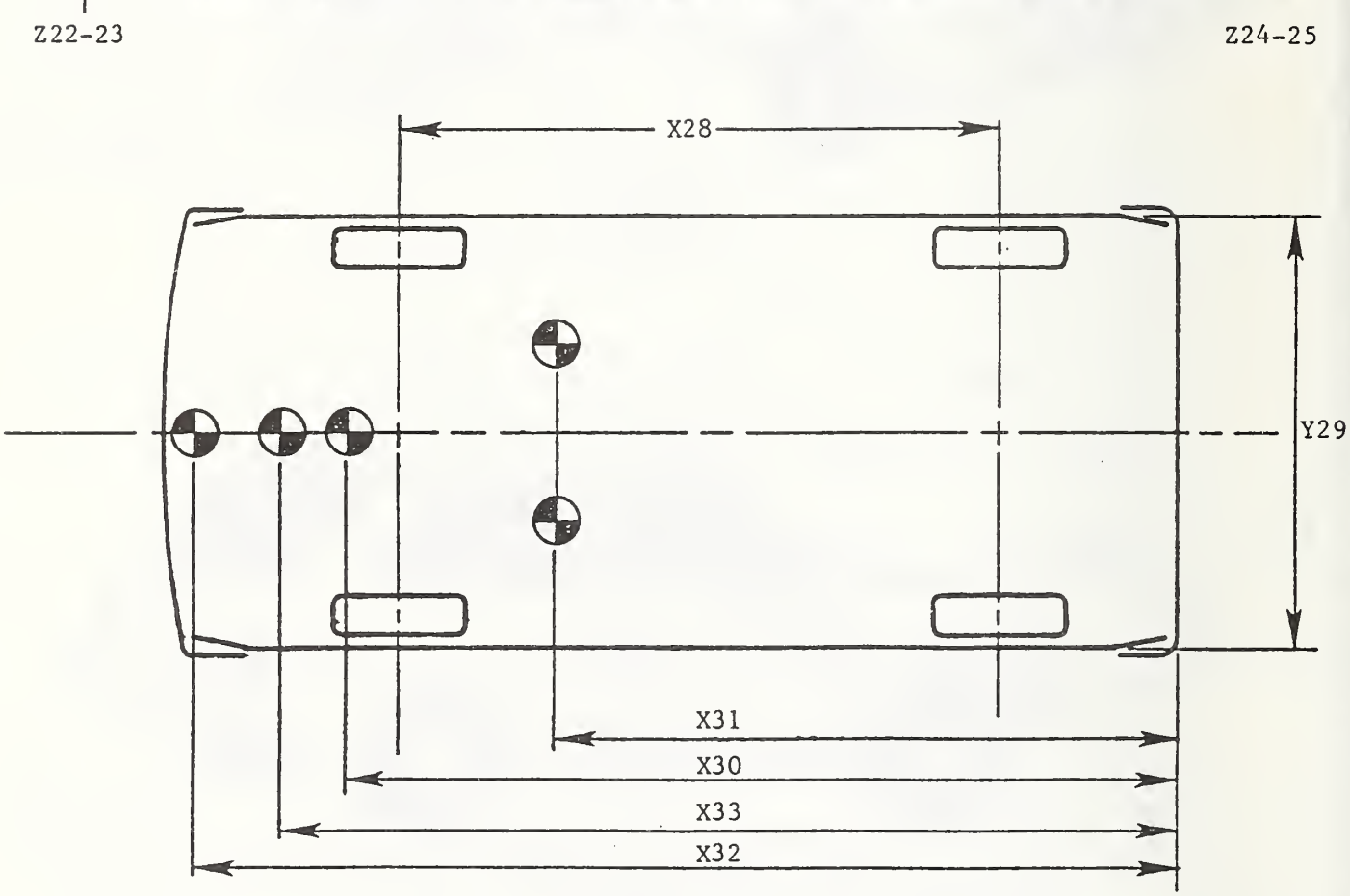


TABLE 5 IMPACTED VEHICLE MEASUREMENTS

VEHICLE MAKE/MODEL: Ford/Mustang TEST NUMBER: 890216

NO.	TYPE OF MEASUREMENT	DIMENSIONS IN INCHES PRE-TEST	POST-TEST	DIFF.
X1	TOTAL LENGTH OF VEHICLE AT CENTERLINE	176.6	165.0	11.6
X2	REAR SURFACE OF VEHICLE TO FRONT OF ENGINE BLOCK	143.8	148.0	-4.2
X3	REAR SURFACE OF VEHICLE TO FIREWALL	124.9	123.8	1.1
X4	REAR SURFACE OF VEHICLE TO UPPER LEADING EDGE OF RIGHT DOOR	112.8	111.8	1.0
X5	REAR SURFACE OF VEHICLE TO UPPER LEADING EDGE OF LEFT DOOR	112.4	112.8	-0.4
X6	REAR SURFACE OF VEHICLE TO LOWER LEADING EDGE OF RIGHT DOOR	115.5	114.4	1.1
X7	REAR SURFACE OF VEHICLE TO LOWER LEADING EDGE OF LEFT DOOR	115.2	114.9	0.3
X8	REAR SURFACE OF VEHICLE TO UPPER TRAILING EDGE OF RIGHT DOOR	65.0	64.9	0.1
X9	REAR SURFACE OF VEHICLE TO UPPER TRAILING EDGE OF LEFT DOOR	65.0	65.2	-0.2
X10	REAR SURFACE OF VEHICLE TO LOWER TRAILING EDGE OF RIGHT DOOR	65.2	64.0	1.2
X11	REAR SURFACE OF VEHICLE TO LOWER TRAILING EDGE OF LEFT DOOR	64.8	64.5	0.3
X12	REAR SURFACE OF VEHICLE TO BOTTOM OF "A" POST ON RIGHT SIDE	114.3	113.5	0.8
X13	REAR SURFACE OF VEHICLE TO BOTTOM OF "A" POST ON LEFT SIDE	114.2	114.2	0.0
X14	REAR SURFACE OF VEHICLE TO FIREWALL - RIGHT SIDE	127.6	125.1	2.5
X15	REAR SURFACE OF VEHICLE TO FIREWALL - LEFT SIDE	127.7	126.8	0.9
X16	REAR SURFACE OF VEHICLE TO STEERING WHEEL CENTER	88.6	87.2	1.4
X17	CENTER OF STEERING COLUMN TO "A" POST	11.1	13.9	-2.8

TABLE 5 IMPACTED VEHICLE MEASUREMENTS, CONT'D.

VEHICLE MAKE/MODEL: Ford/Mustang TEST NUMBER: 890216

NO.	TYPE OF MEASUREMENT	DIMENSIONS IN INCHES PRE-TEST	POST-TEST	DIFF.
Z18	REAR OF WINDSHIELD HEADER TO STEERING WHEEL CENTER	16.3	14.4	1.9
X19	REAR SURFACE OF VEHICLE TO RIGHT SIDE OF FRONT BUMPER	175.1	165.0	10.1
X20	REAR SURFACE OF VEHICLE TO LEFT SIDE OF FRONT BUMPER	175.0	163.0	12.0
X21	LENGTH OF ENGINE BLOCK	17.5	17.5	0.0
Z22	RIGHT FRONT SILL TO GROUND PLANE	9.6	7.6	2.0
Z23	LEFT FRONT SILL TO GROUND PLANE	9.3	6.1	3.2
Z24	RIGHT REAR SILL TO GROUND PLANE	9.8	10.1	-0.3
Z25	LEFT REAR SILL TO GROUND PLANE	9.2	9.0	0.2
X26	FIREWALL TO ENGINE OR TRANSAXLE	4.0	0.0	4.0
Z27	VERTICAL DIMENSION FROM DOOR SILL TO CENTERLINE OF STEERING COLUMN	20.6	22.4	-1.8
X28	WHEELBASE OF VEHICLE	100.8	100.0	0.8
Y29	WIDTH OF VEHICLE AT MAXIMUM WIDTH POINT	69.2	78.1	-8.9
X30	REAR SURFACE OF VEHICLE TO ENGINE TARGET	136.1	133.8	2.3
X31	REAR SURFACE OF VEHICLE TO COMPARTMENT TARGET	108.1	105.9	2.2
X32	REAR SURFACE OF VEHICLE TO BUMPER TARGET	170.9	156.1	14.8
X33	REAR SURFACE OF VEHICLE TO FRAME CROSSMEMBER	144.1	143.0	1.1

SECTION 2.0

SUMMARY OF RESULTS

TABLE 6

DUMMY DATA SUMMARY

TEST NUMBER 890216

	DRIVER DUMMY SN: 830			
	POSITIVE DIRECTION		NEGATIVE DIRECTION	
	MAX	MSEC	MAX	MSEC
HEAD ACCELERATION (g)				
LONGITUDINAL	31.4	74.0	58.3	97.3
LATERAL	7.9	115.6	8.2	74.8
VERTICAL	9.0	125.4	49.0	78.8
RESULTANT	65.4	95.3		
HIC	571.5 FROM 75.6 TO 109.8			
CHEST ACCELERATION (g)				
LONGITUDINAL	7.2	235.6	48.2	96.4
LATERAL	5.1	32.3	5.9	88.3
VERTICAL	7.3	124.8	11.1	88.6
RESULTANT	48.2	96.4		
3 MSEC	47.7			
FEMUR LOAD (lb)				
LEFT	293.4	30.0	1505.3	78.3
RIGHT	162.9	30.1	1035.1	74.6

POSITIVE DIRECTION		NEGATIVE DIRECTION	
LONGITUDINAL:	FORWARD	LONGITUDINAL:	REARWARD
LATERAL:	LEFTWARD	LATERAL:	RIGHTWARD
VERTICAL:	UPWARD	VERTICAL:	DOWNWARD
FORCE:	TENSION	FORCE:	COMPRESSIO

DUMMY KINEMATIC SUMMARY

DRIVER DUMMY

Upon impact, the driver dummy translated forward on the seat impacting both knees into the instrument panel. The driver's upper torso rotated forward as the driver's head and chest were restrained by the driver's airbag. The dummy rebounded into the seat back and came to rest seated upright in the driver's seat.

VISIBLE DUMMY CONTACT POINTS:

	DRIVER #830	PASSENGER #NA
Head	Airbag	NA
Chest	Airbag	NA
Abdomen	None	NA
Left knee	Instrument panel	NA
Right knee	Instrument panel	NA

DOOR OPENING:

	LEFT	RIGHT
Front	Easy	Tools required
Rear	NA	NA

SEAT MOVEMENT:

	SEAT BACK FAILURE	SEAT SHIFT
Front	None	None
Rear	NA	NA

GLAZING DAMAGE:

The windshield was cracked upon impact.

OTHER NOTABLE IMPACT EFFECTS:

None

FIGURE 5 DUMMY IN-VEHICLE POSITION RECORDING SHEET

MFR./MAKE/MODEL: Ford Mustang

SEAT TYPE: ____Bench
__X__Bucket
____Split bench

ADJUSTER TYPE: __X__Manual
____Power
____Non-adjustable

BUCKET SEAT BACK TYPE: ____Non-adjustable
__X__Adjustable reclining

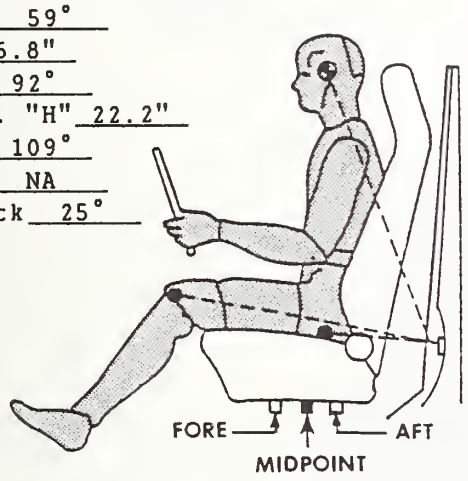
POSITIONING DATE: 2/16/89

AMBIENT TEMP. 70° F TIME: 0830

TECHNICIANS:
1. B. Crabtree
2. B. Fishbaugh
3. _____
4. _____

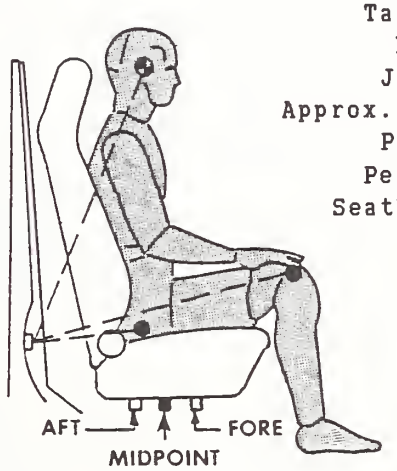
DRIVER DUMMY* # 830 TYPE: HII

Head 22.8"
Target 59°
Knee 36.8"
Joint 92°
Approx. "H" 22.2"
Point 109°
Pelvis NA
Seatback 25°

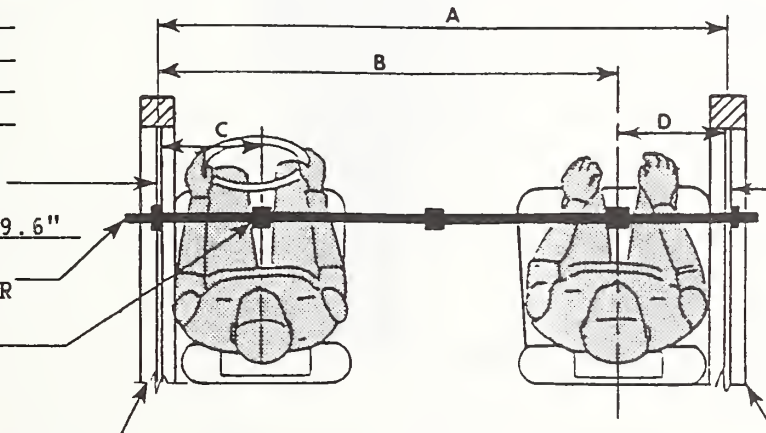


PASSENGER DUMMY* # NA TYPE: NA

Head _____
Target _____
Knee _____
Joint _____
Approx. "H" _____
Point _____
Pelvis _____
Seatback _____



A = 52.2"
B = NA
C = 11.0"
D = NA



DOOR GLASS HEIGHT = 9.6"

LATERAL BAR

ADJUSTABLE POINTER

DOOR GLASS HEIGHT = 9.6"

LEFT FRONT DOOR

DRIVER DUMMY

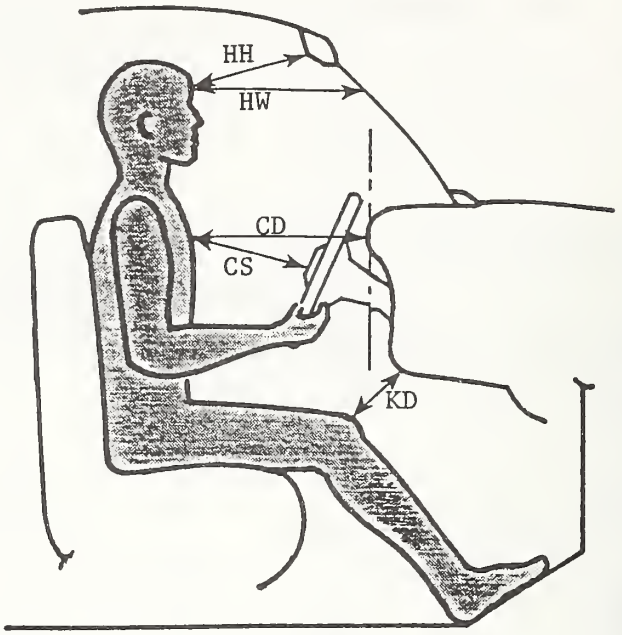
PASSENGER DUMMY

RIGHT FRONT DOOR

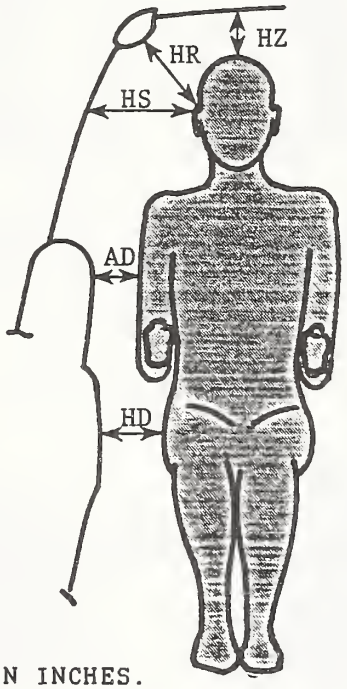
*Dummy measurements are referenced to top of striker bolt and all angles are referenced to vertical.

FIGURE 6 DUMMY IN-VEHICLE POSITION RECORDING SHEET

	DRIVER	PASSENGER
HH	15.2	NA
HW	21.5	NA
CD	21.4	NA
CS	11.6	NA
KDL	4.4	NA
KDR	4.6	NA

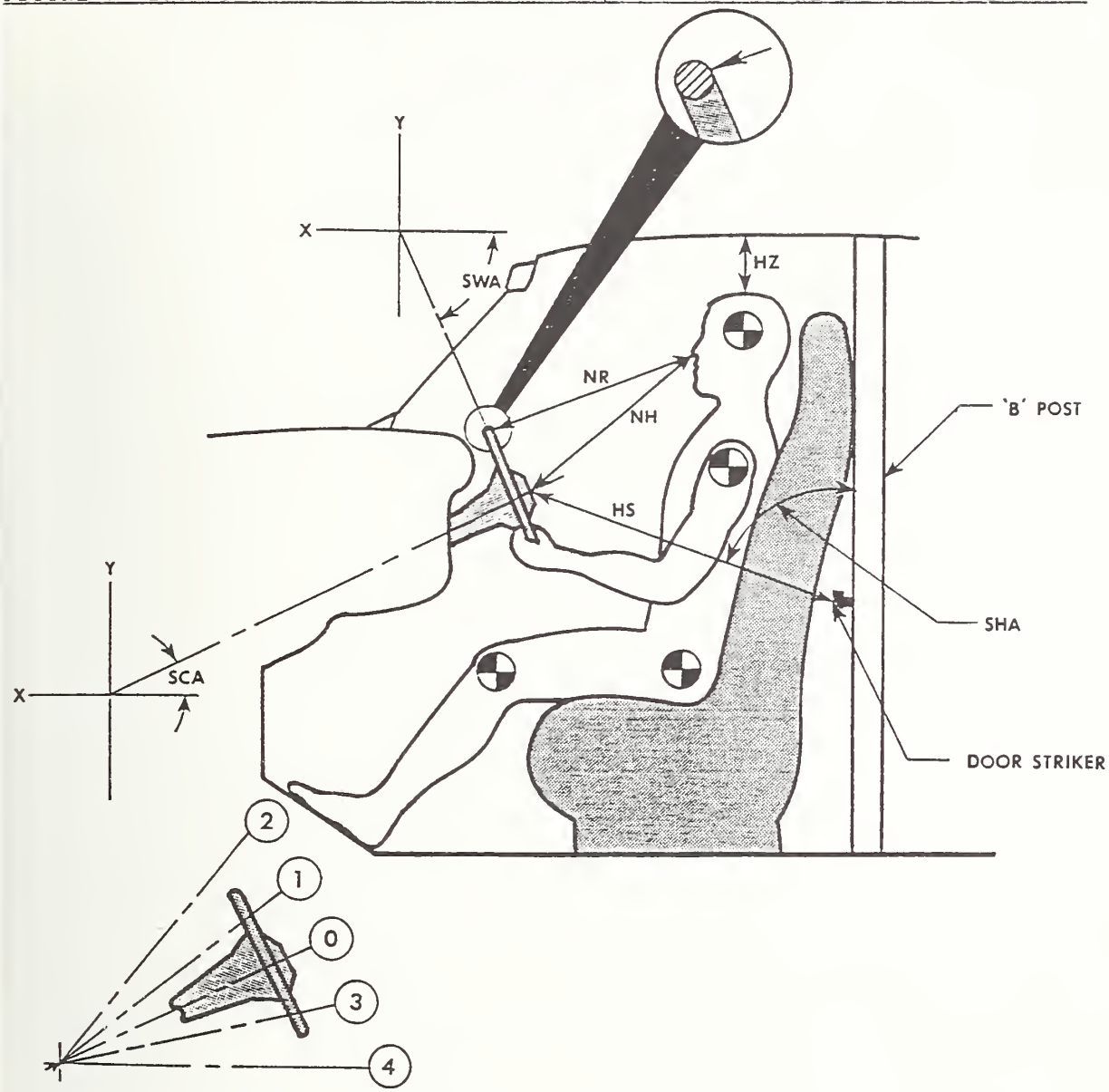


	DRIVER	PASSENGER
HR	5.4	NA
HS	7.9	NA
AD	4.0	NA
HD	6.6	NA
HZ	2.4	NA



ALL DISTANCE MEASUREMENTS ARE IN INCHES.

FIGURE 7 DRIVER DUMMY TO STEERING COLUMN/WHEEL ASSY. REFERENCE DIMENSIONS



	PRE-TEST
NR	16.4
NH	16.5
HS	31.8
SCA	23°
SWA	67°
HZ	2.4
SHA	25°

ALL DISTANCE MEASUREMENTS ARE IN INCHES.

SECTION 3.0

CAMERA INFORMATION

FIGURE 8

CAMERA POSITIONS

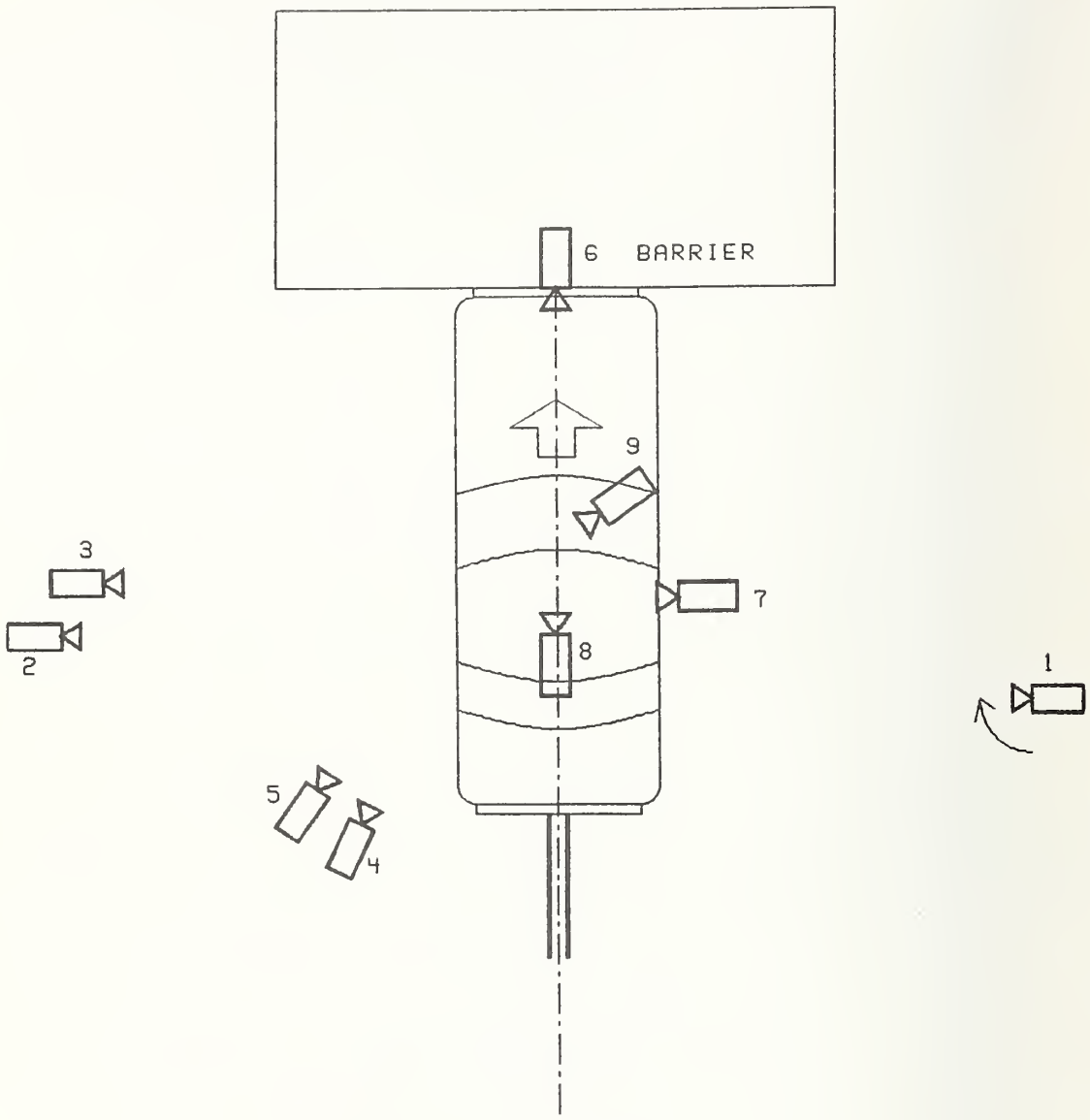


TABLE 7 CAMERA INFORMATION

CAMERA NO.	LOCATION	TYPE	LENS (mm)	SPEED (fps)	PURPOSE OF CAMERA DATA
1	Real-time panning	Kodak	17	24	Real-time documentation
2	Left wide	Photosonic 1B	13	998	Vehicle crush
3	Left medium tight	Hycam	25	995	Dummy kinematics
4	Left angle	Photosonic 1B	25	998	Dummy kinematics
5	Left airbag	Hycam	16	2990	Airbag inflation
6	Barrier	Photosonic 1B	13	998	Dummy/airbag kinematics
7	Onboard door	Photosonic 1B	8	972	Dummy/airbag kinematics
8	Onboard roof	Photosonic 1B	8	1000	Dummy/airbag kinematics
9	Onboard floor	Photosonic 1B	8	995	Dummy/airbag kinematics

APPENDIX A

PHOTOGRAPHS

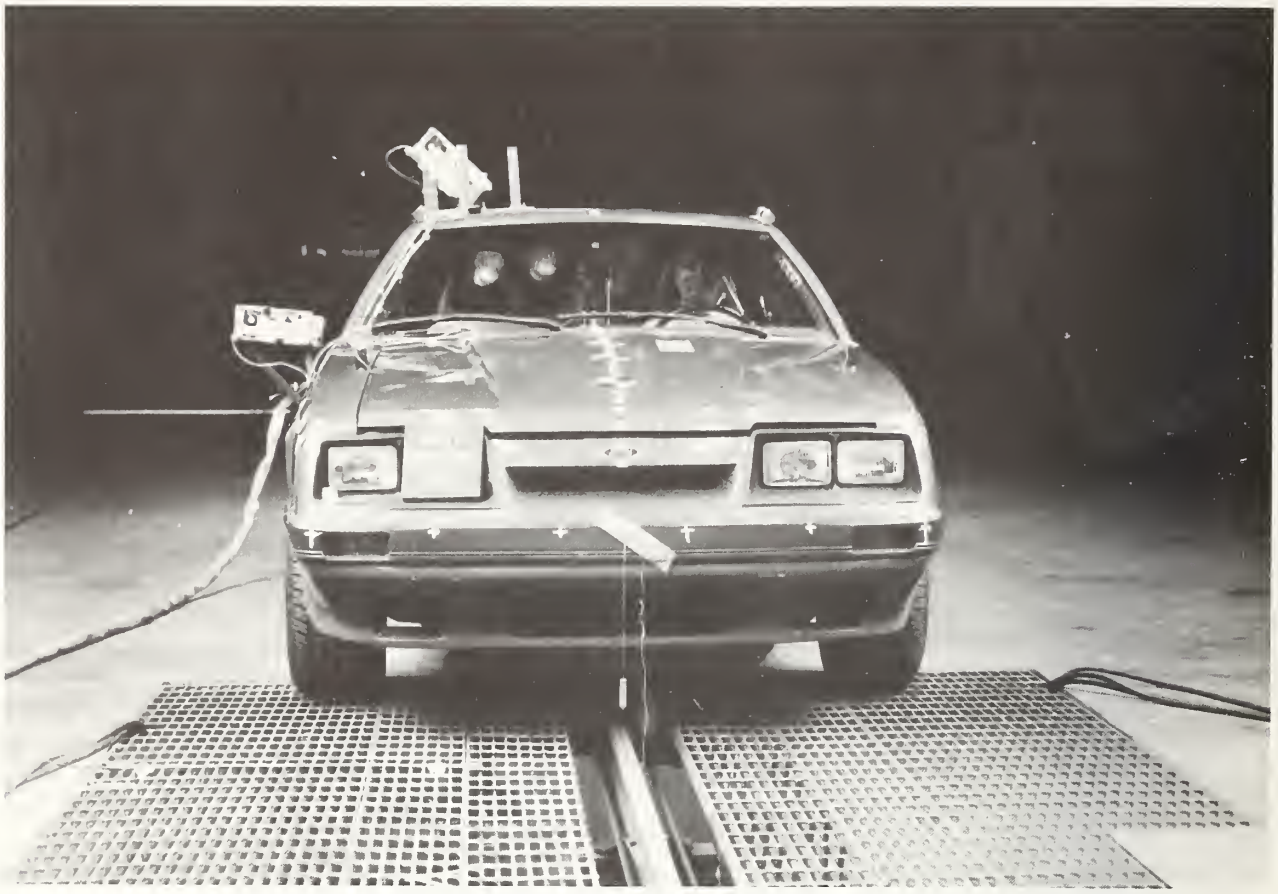


Figure A-1. PRE-TEST FRONT VIEW

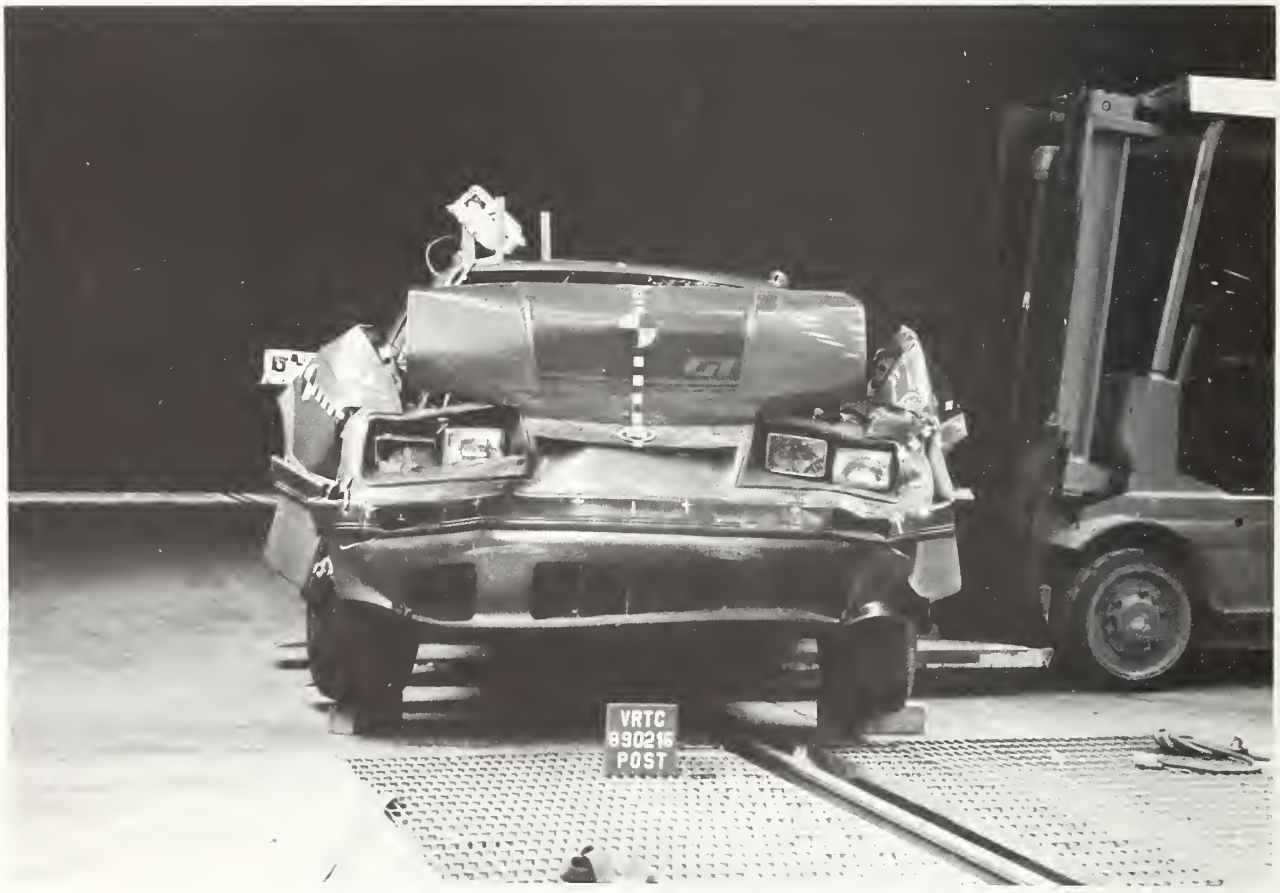


Figure A-2. POST-TEST FRONT VIEW

Figure A-3. PRE-TEST LEFT SIDE VIEW

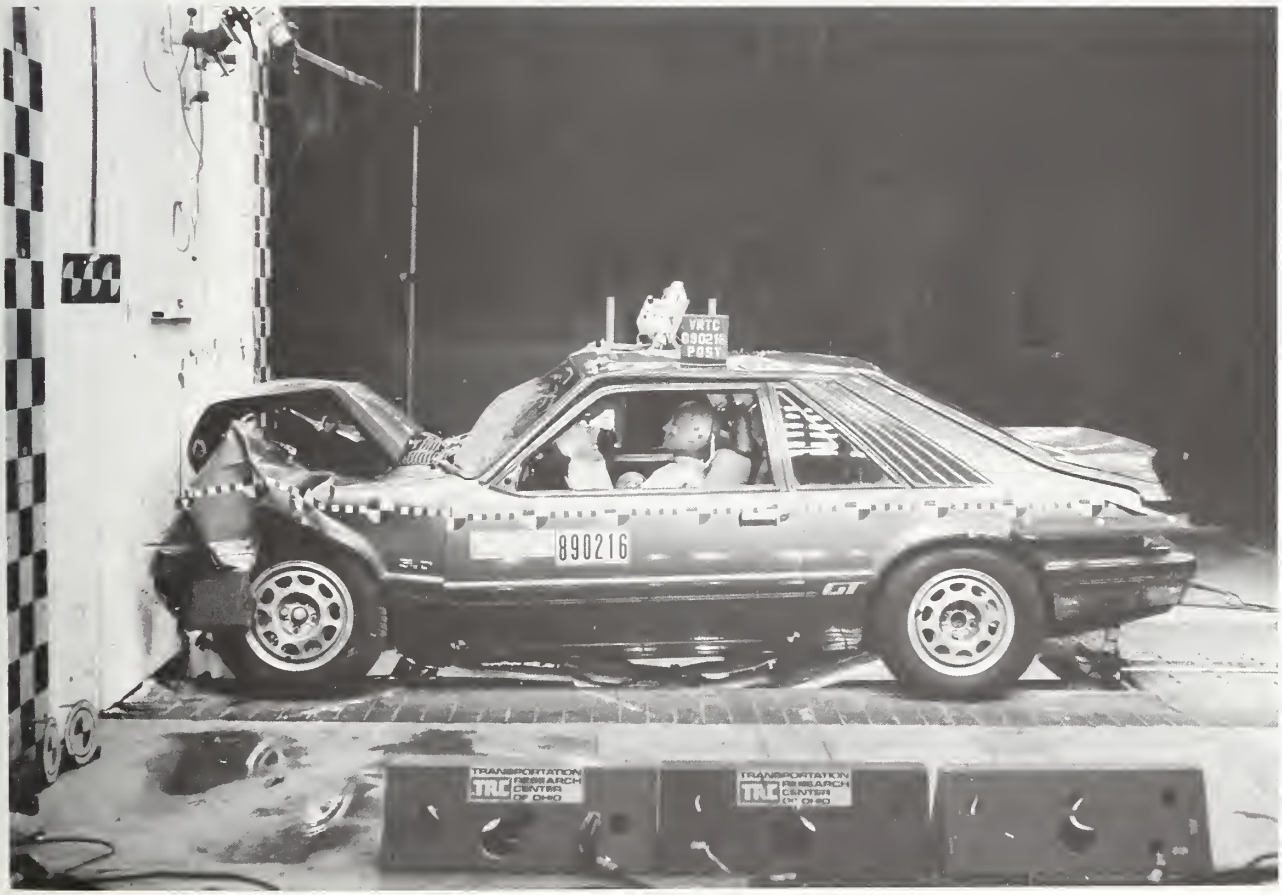


Figure A-4. POST-TEST LEFT SIDE VIEW

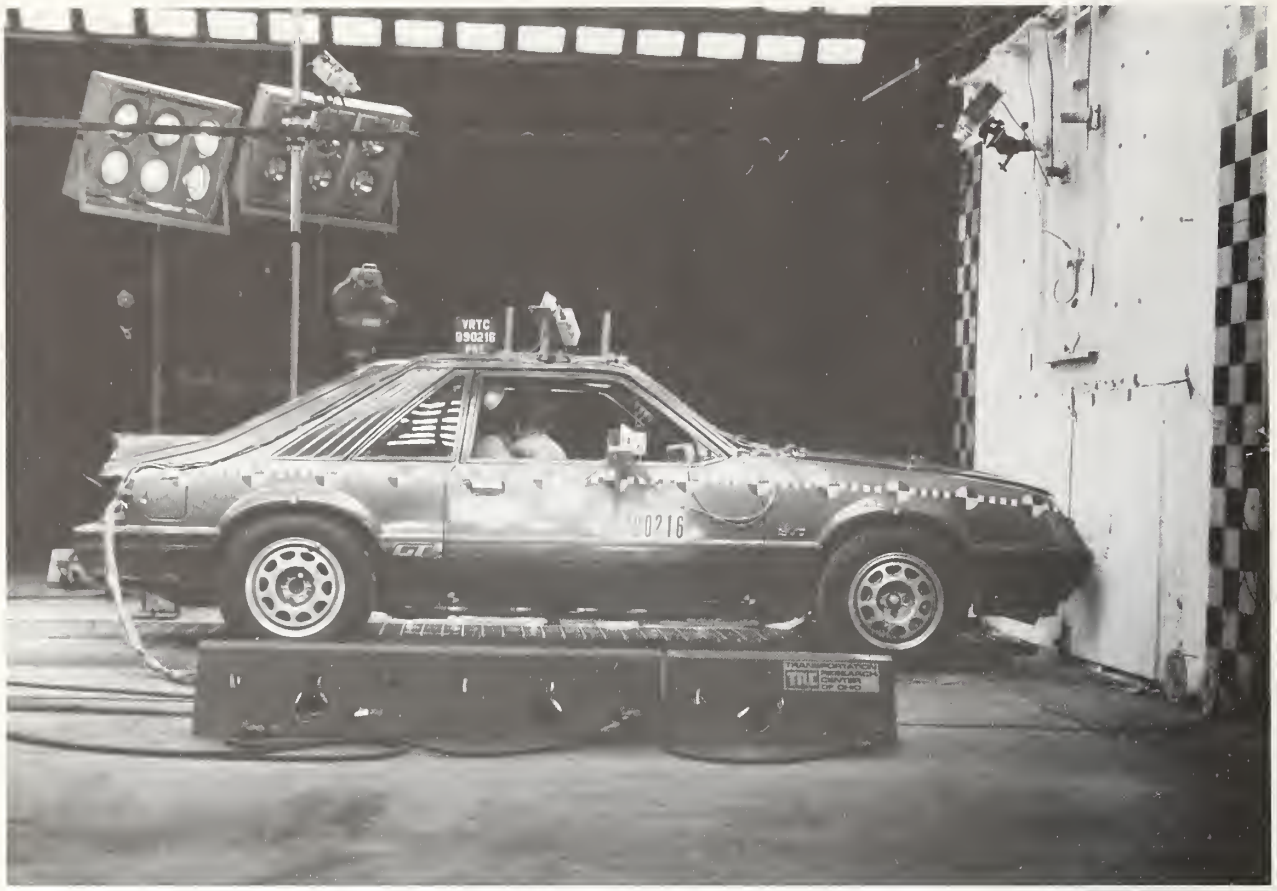


Figure A-5. PRE-TEST RIGHT SIDE VIEW

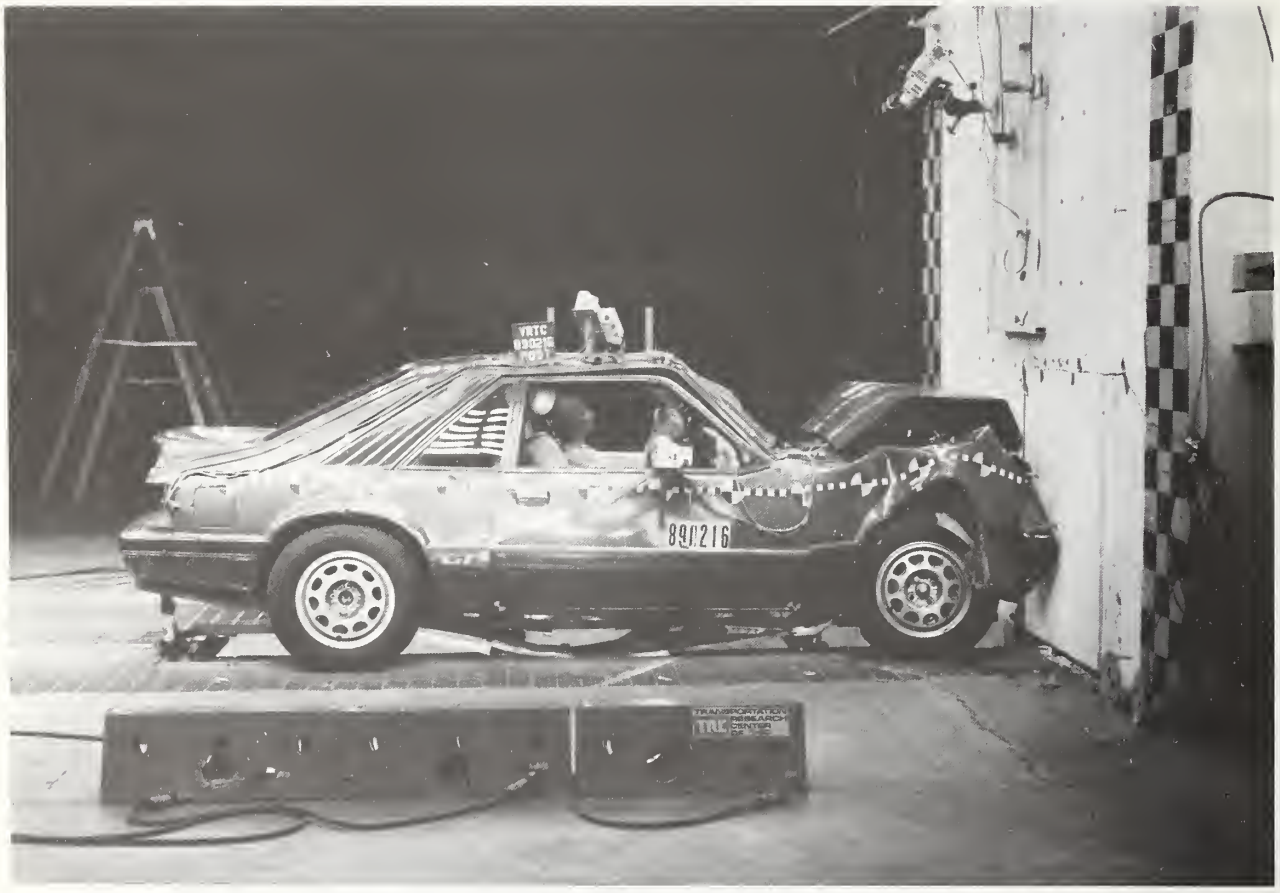


Figure A-6. POST-TEST RIGHT SIDE VIEW

Figure A-7. PRE-TEST RIGHT FRONT THREE-QUARTER VIEW

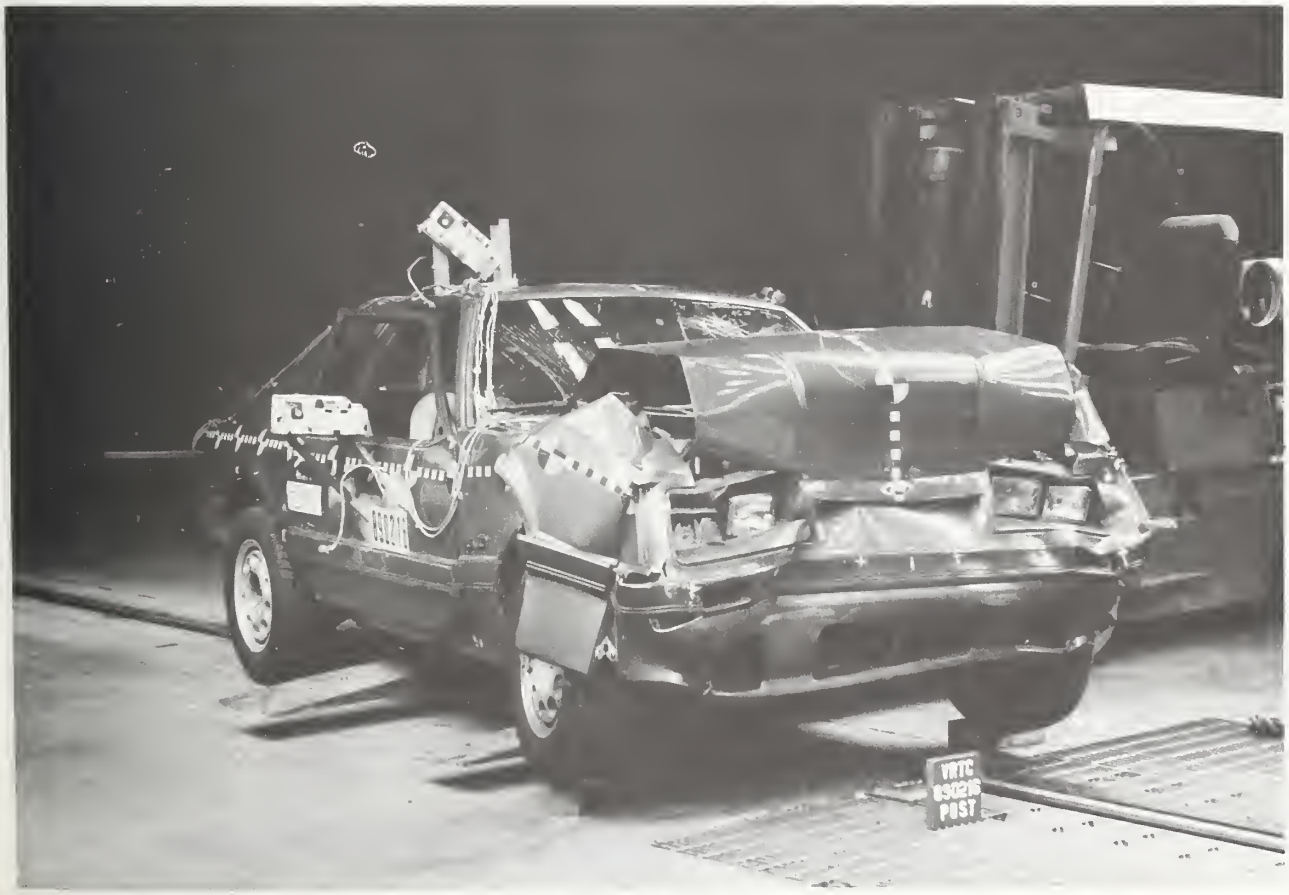


Figure A-8. POST-TEST RIGHT FRONT THREE-QUARTER VIEW

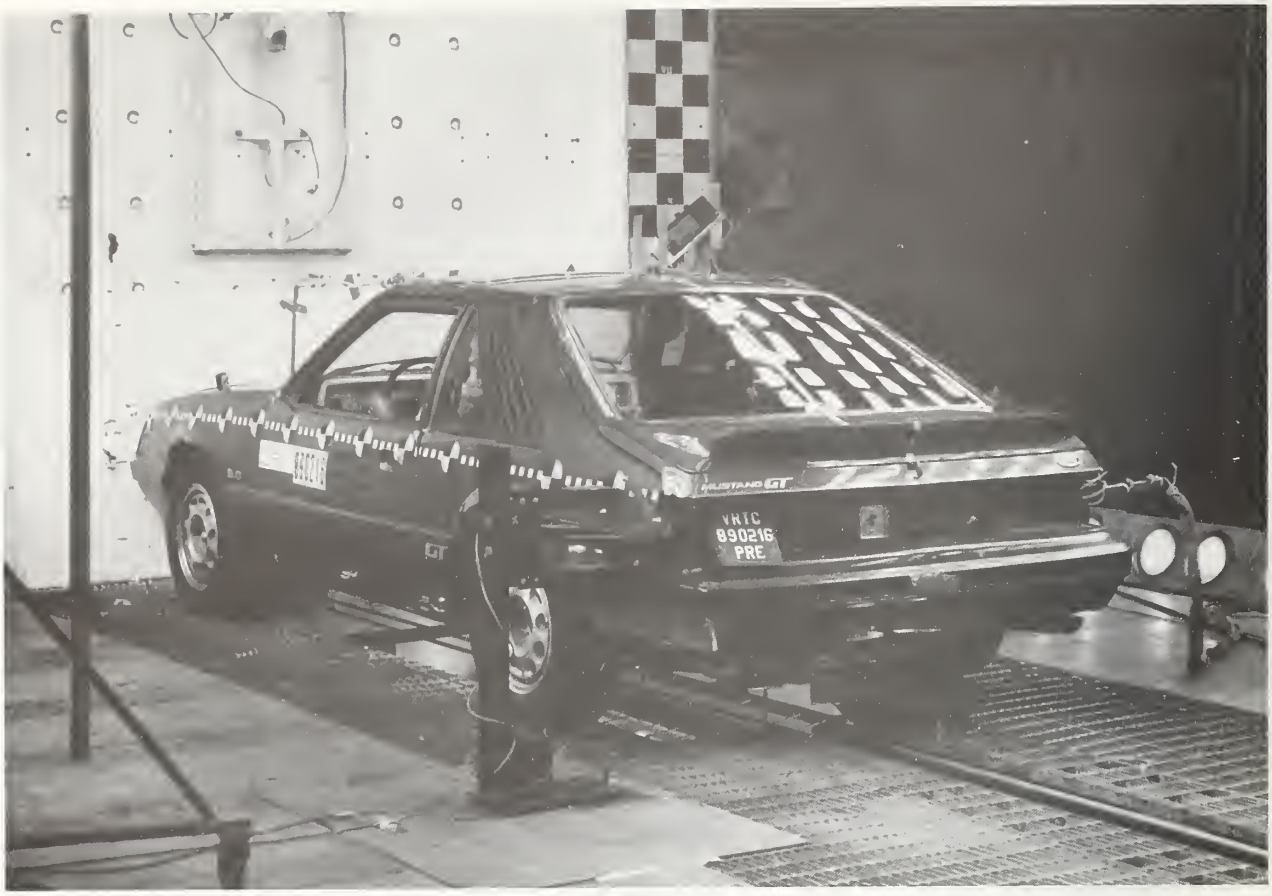


Figure A-9. PRE-TEST LEFT REAR THREE-QUARTER VIEW

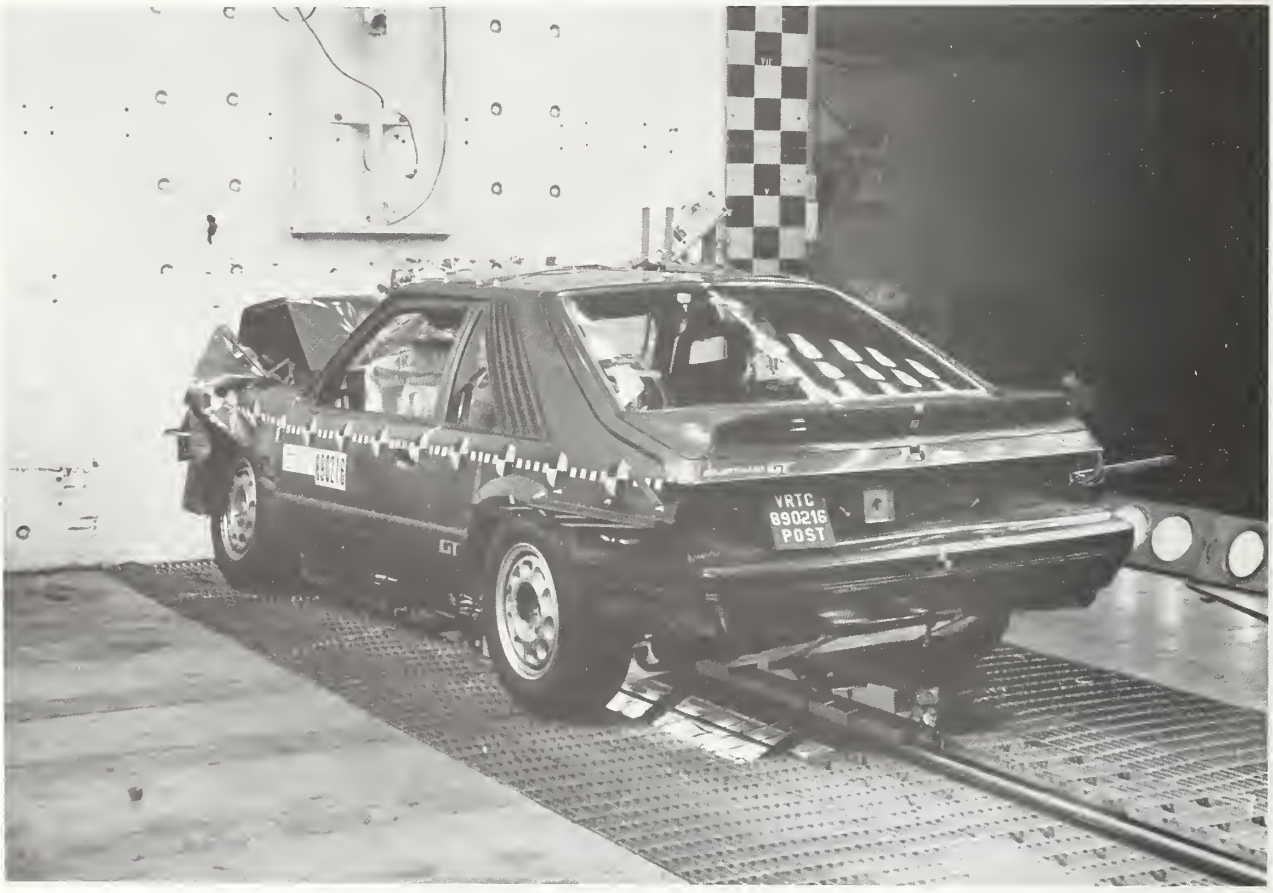


Figure A-10. POST-TEST LEFT REAR THREE-QUARTER VIEW

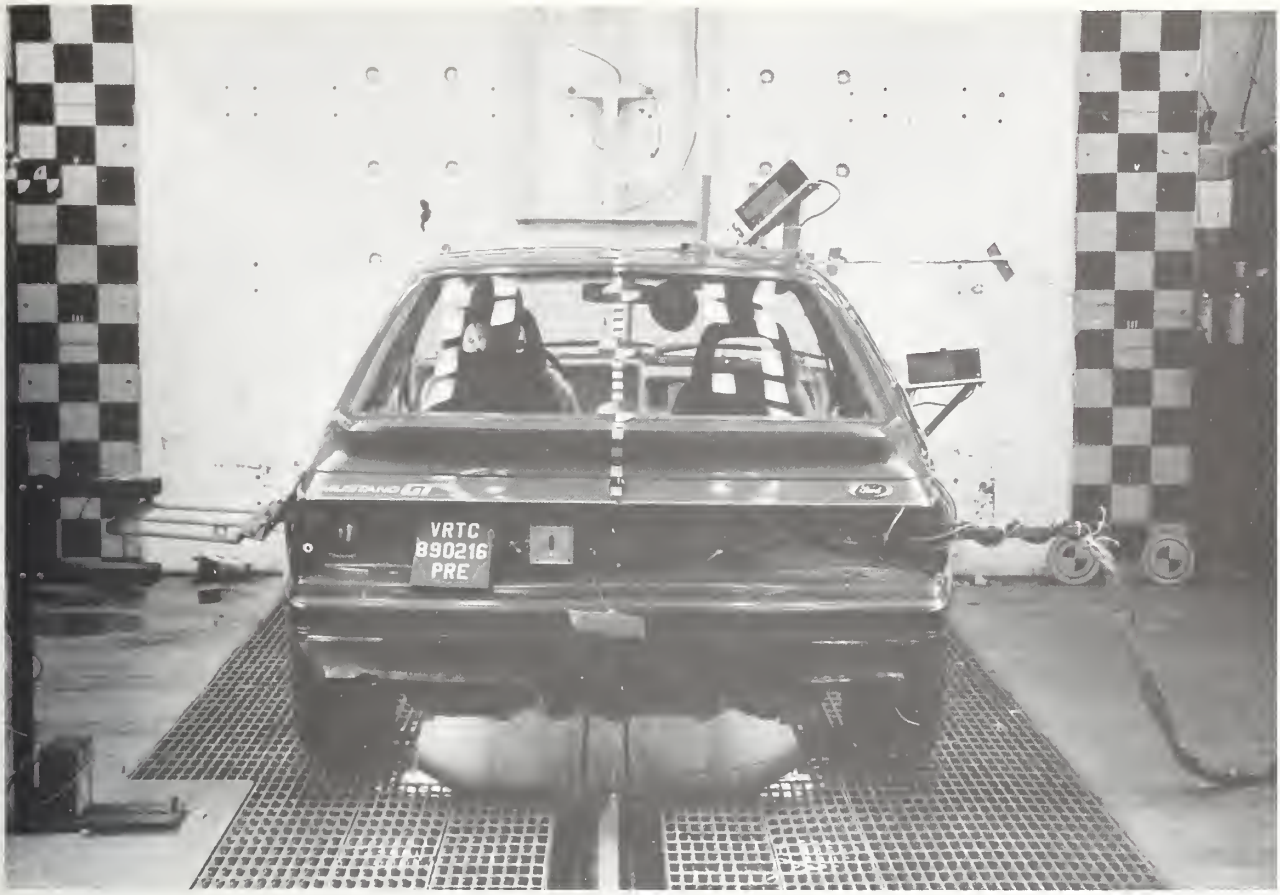


Figure A-11. PRE-TEST REAR VIEW

Figure A-12. POST-TEST REAR VIEW

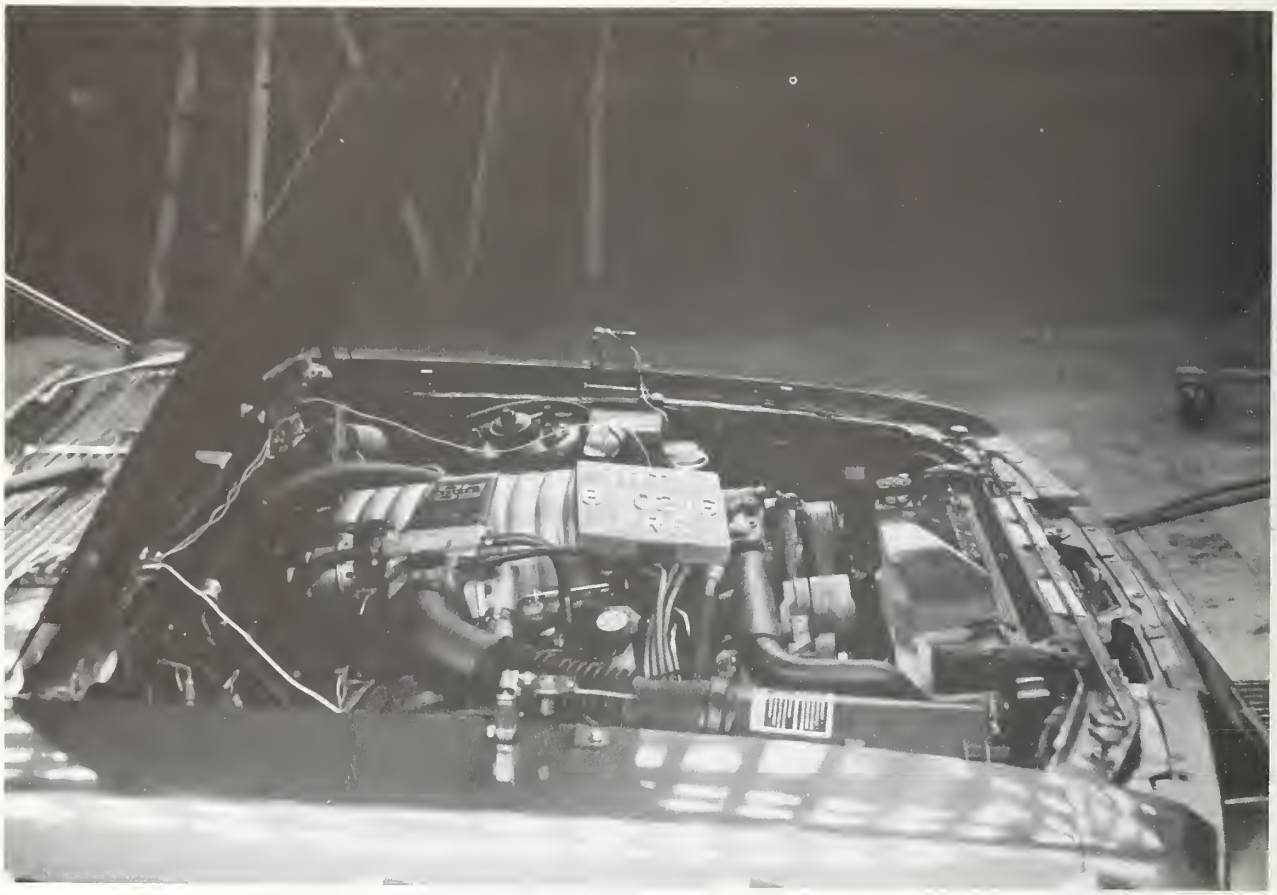


Figure A-13. PRE-TEST ENGINE COMPARTMENT VIEW

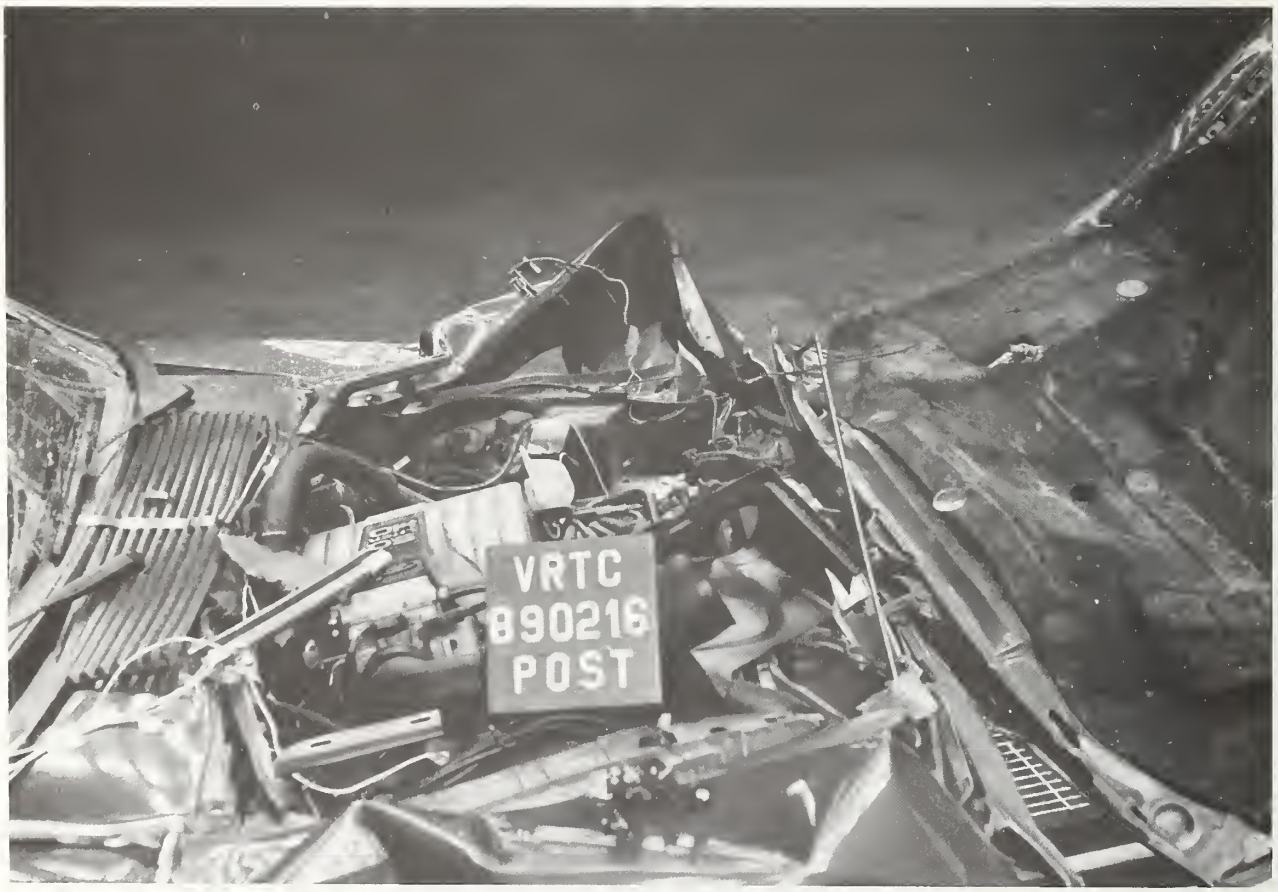


Figure A-14. POST-TEST ENGINE COMPARTMENT VIEW

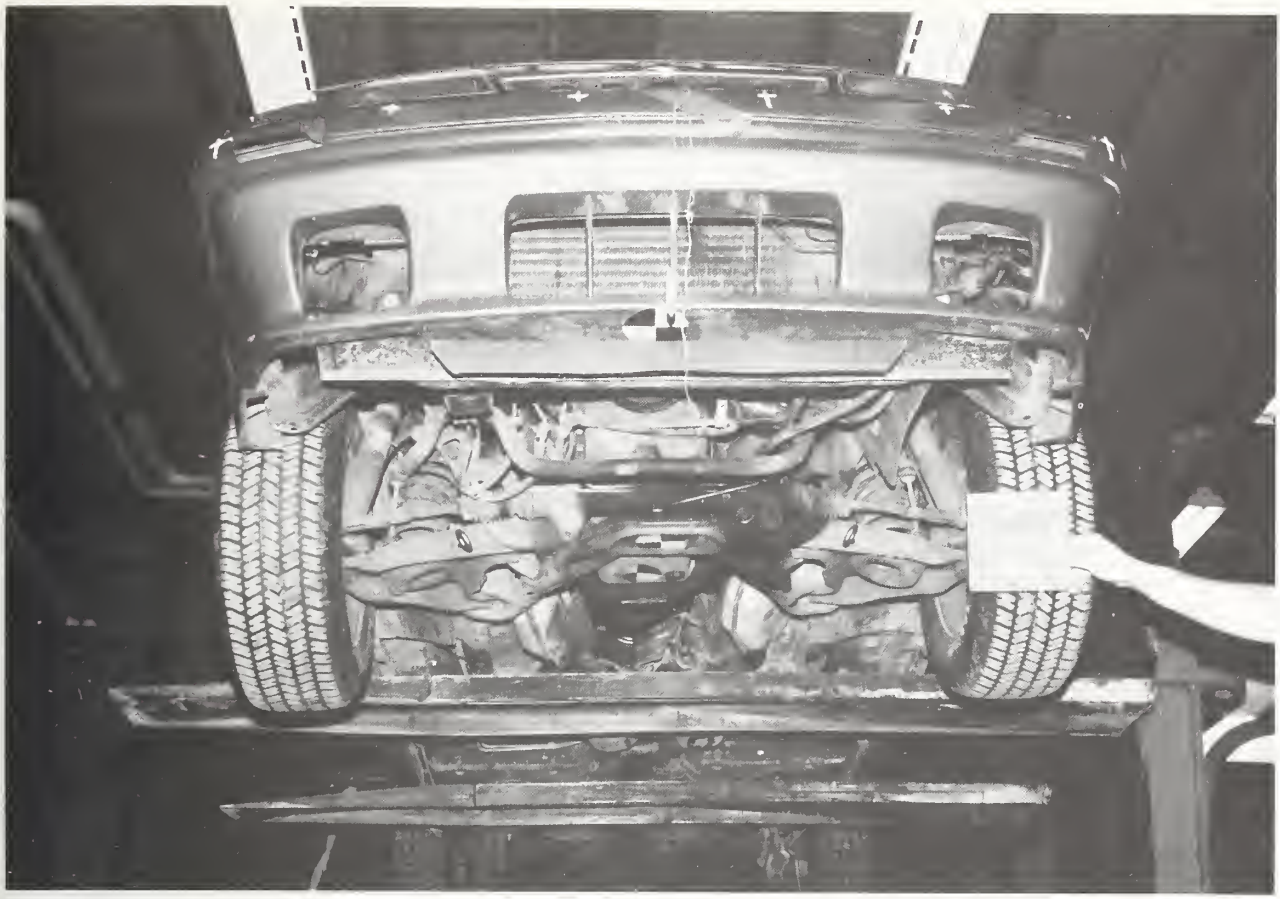


Figure A-15. PRE-TEST FRONT UNDERBODY VIEW

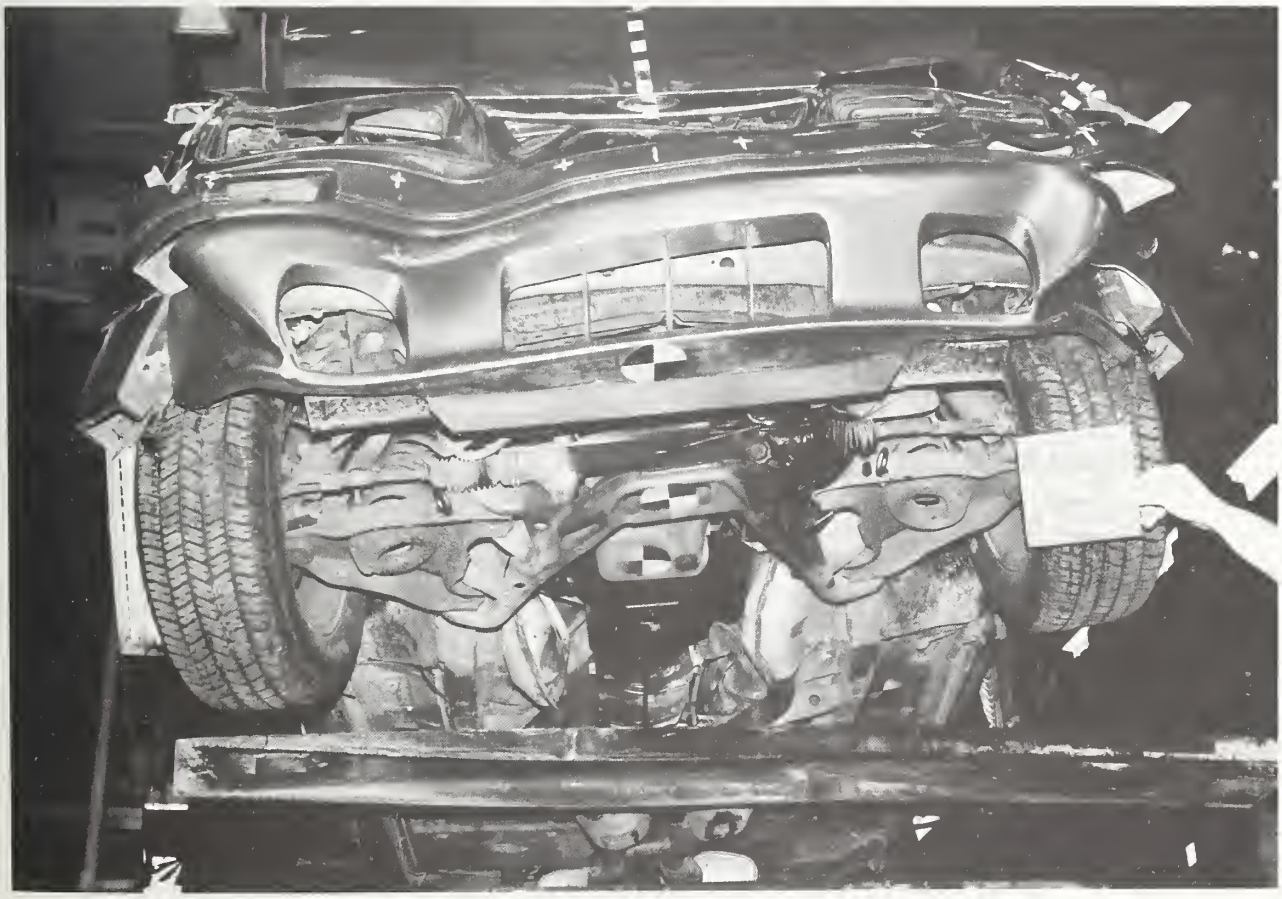


Figure A-16. POST-TEST FRONT UNDERBODY VIEW

Figure A-17. PRE-TEST DRIVER DUMMY POSITION VIEW

Figure A-18. POST-TEST DRIVER DUMMY POSITION VIEW

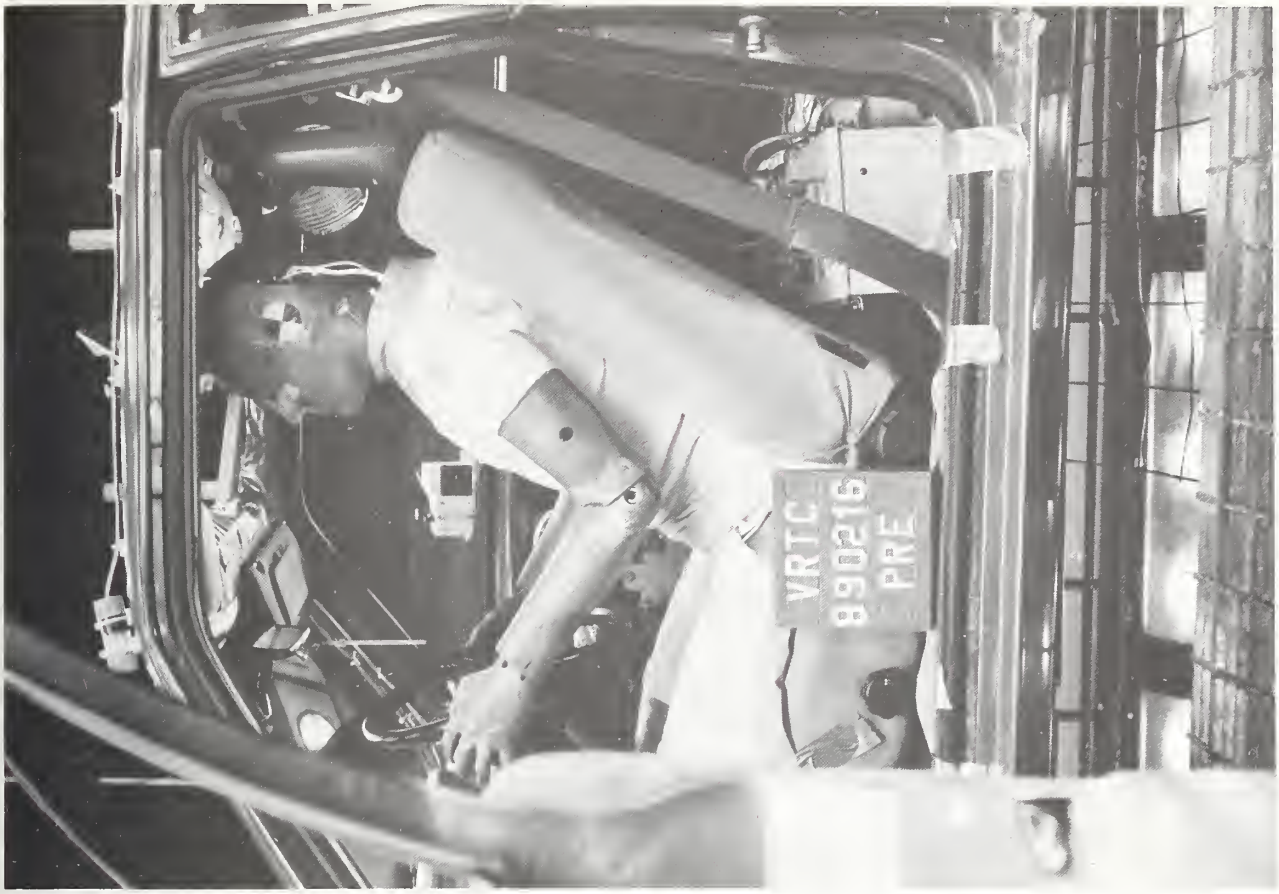


Figure A-19. PRE-TEST DRIVER DUMMY & VEHICLE INTERIOR - VIEW 1

Figure A-20. POST-TEST DRIVER DUMMY & VEHICLE INTERIOR - VIEW 1

Figure A-21. PRE-TEST DRIVER DUMMY & VEHICLE INTERIOR - VIEW 2

Figure A-22. POST-TEST DRIVER DUMMY & VEHICLE INTERIOR - VIEW 2

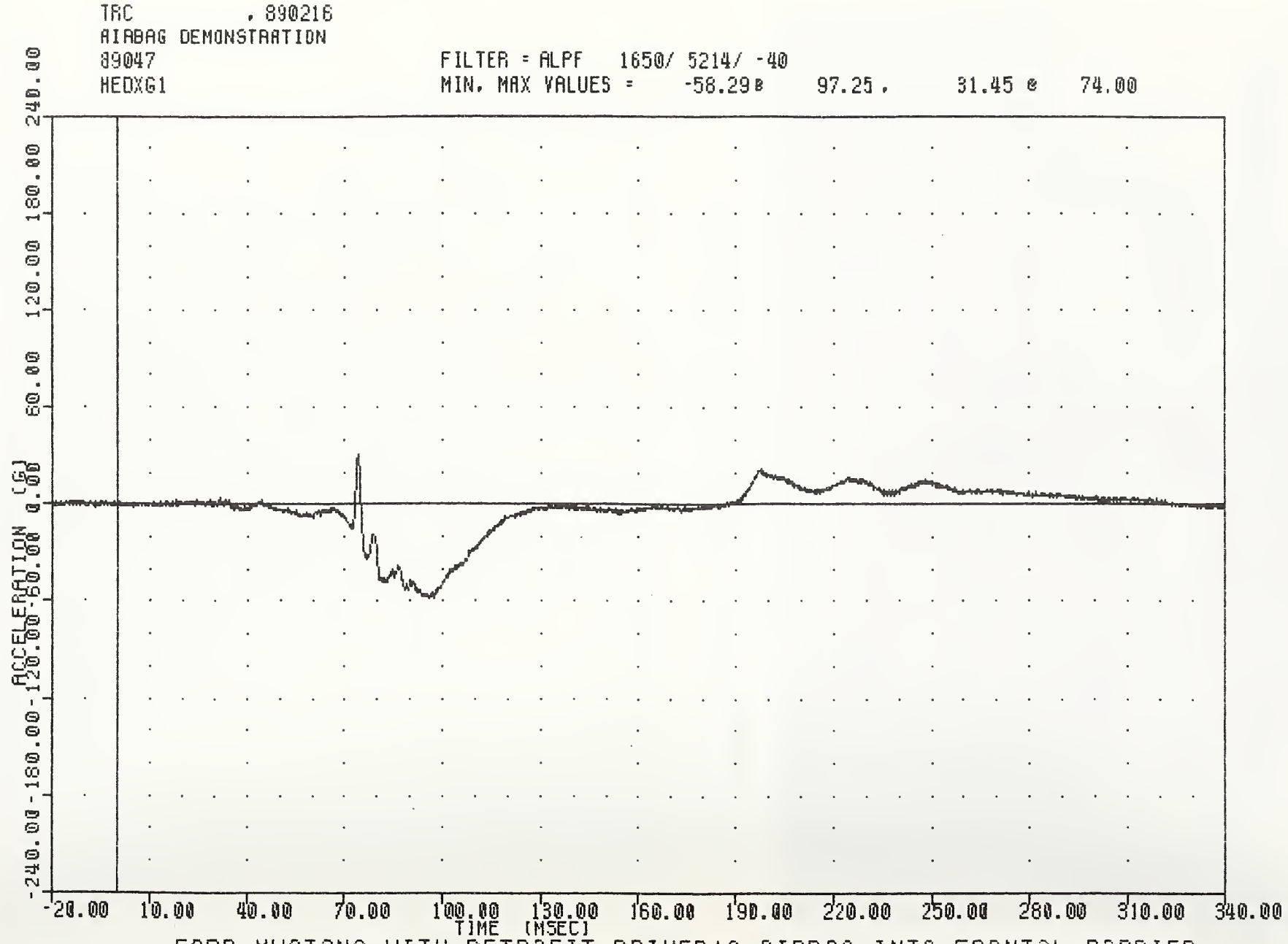
Figure A-23. POST-TEST DRIVER DUMMY HEAD CONTACT

Figure A-24. PRE-TEST DRIVER DUMMY KNEE BLOCKER MODIFICATION

Figure A-25. POST-TEST DRIVER DUMMY KNEE CONTACT

APPENDIX B

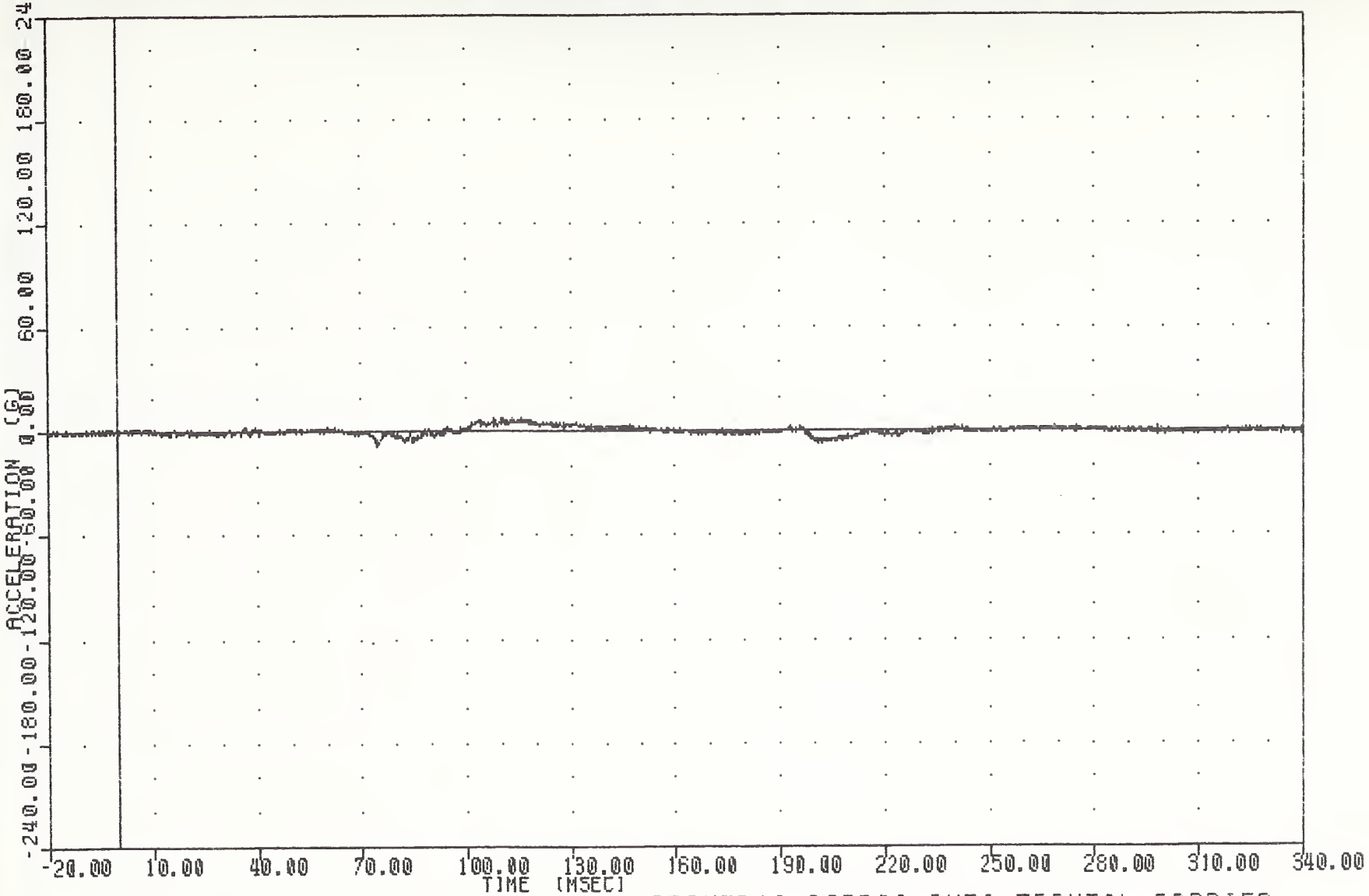
DATA PLOTS



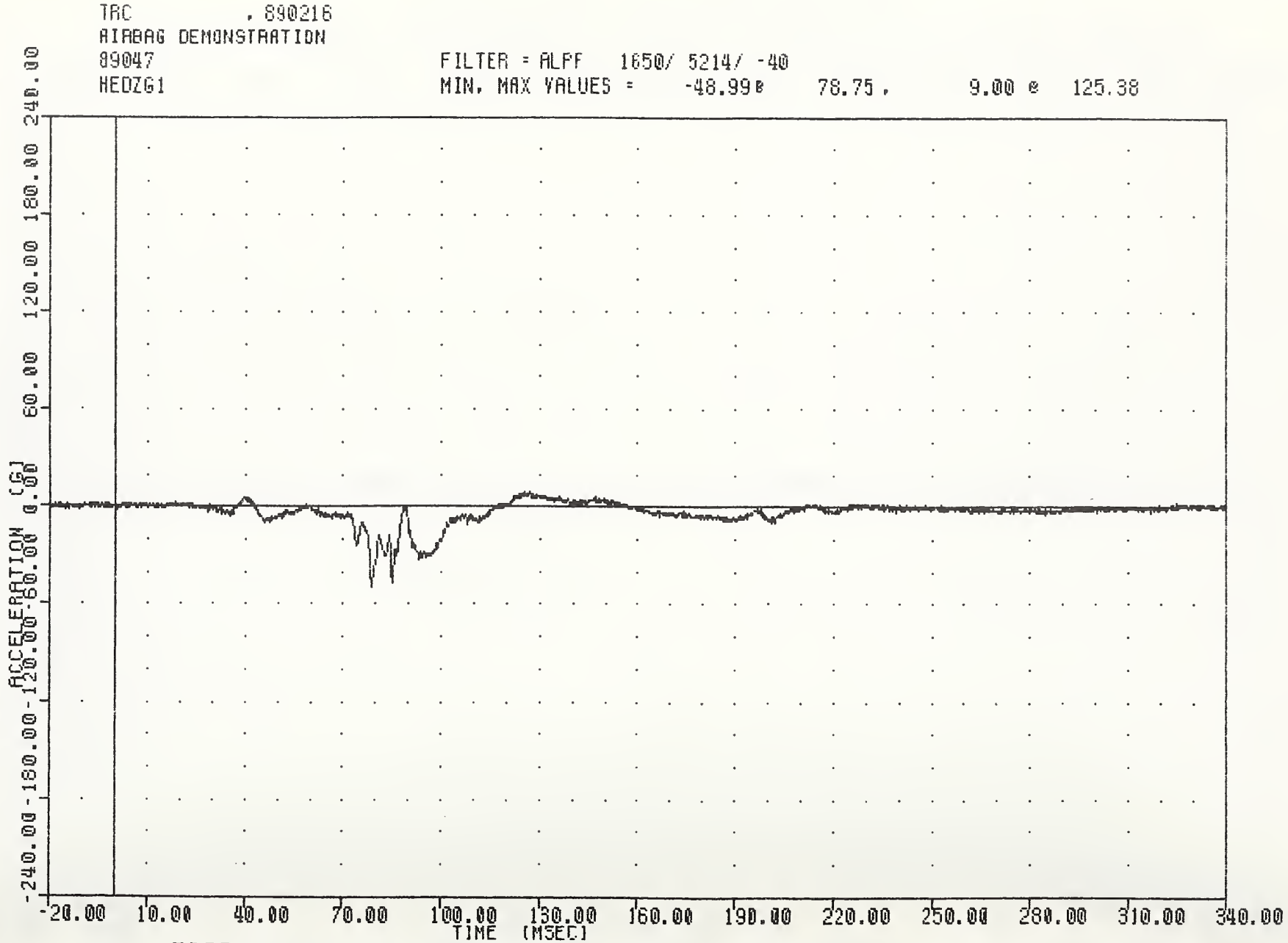
FORD MUSTANG WITH RETROFIT DRIVER'S AIRBAG INTO FRONTAL BARRIER
DRIVER HEAD X AXIS ACCELERATION

TRC , 890216
AIRBAG DEMONSTRATION
89047
HEDYG1

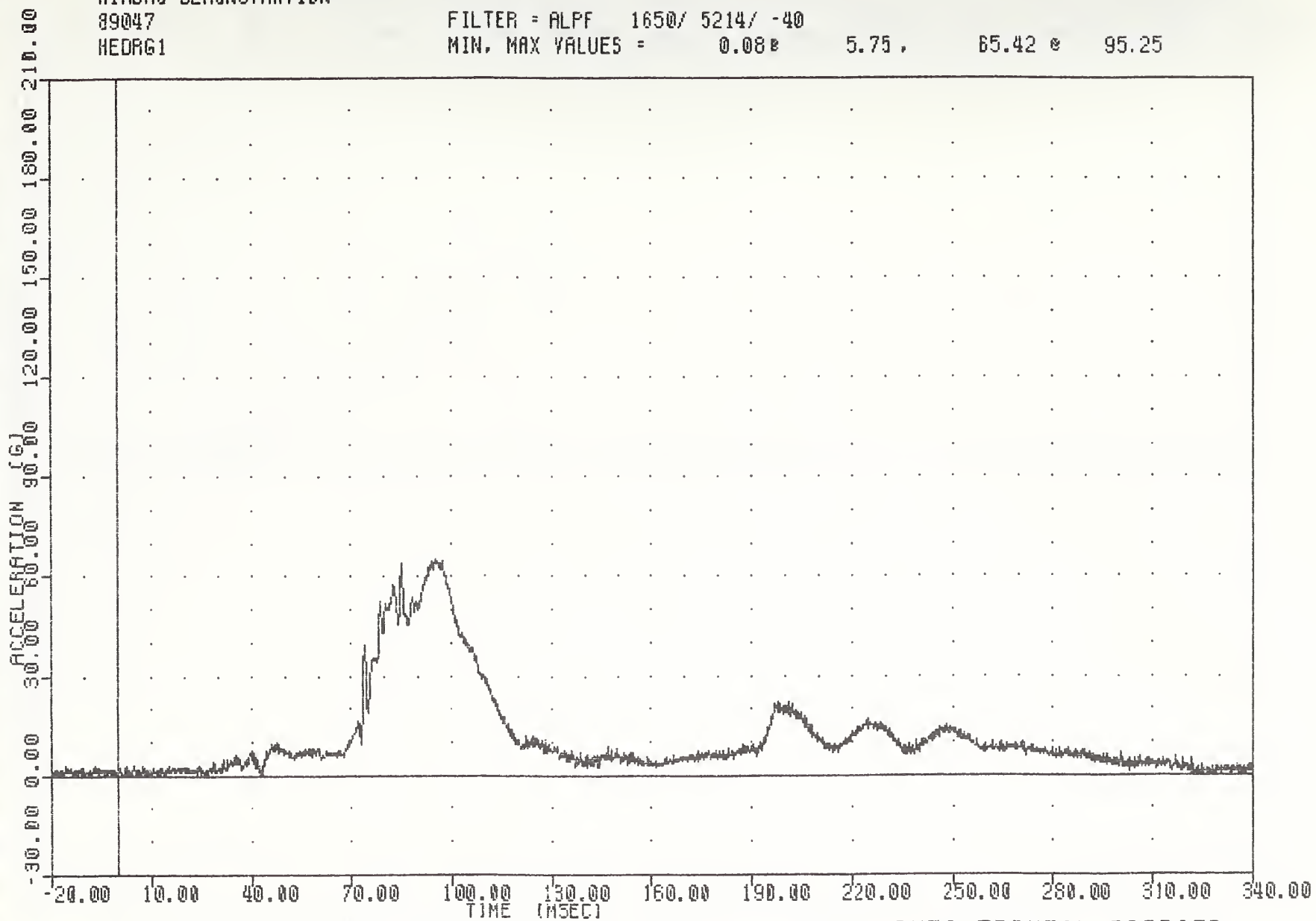
FILTER = ALPF 1650/ 5214/ -40
MIN, MAX VALUES = -8.20 @ 74.75 , 7.85 @ 115.63



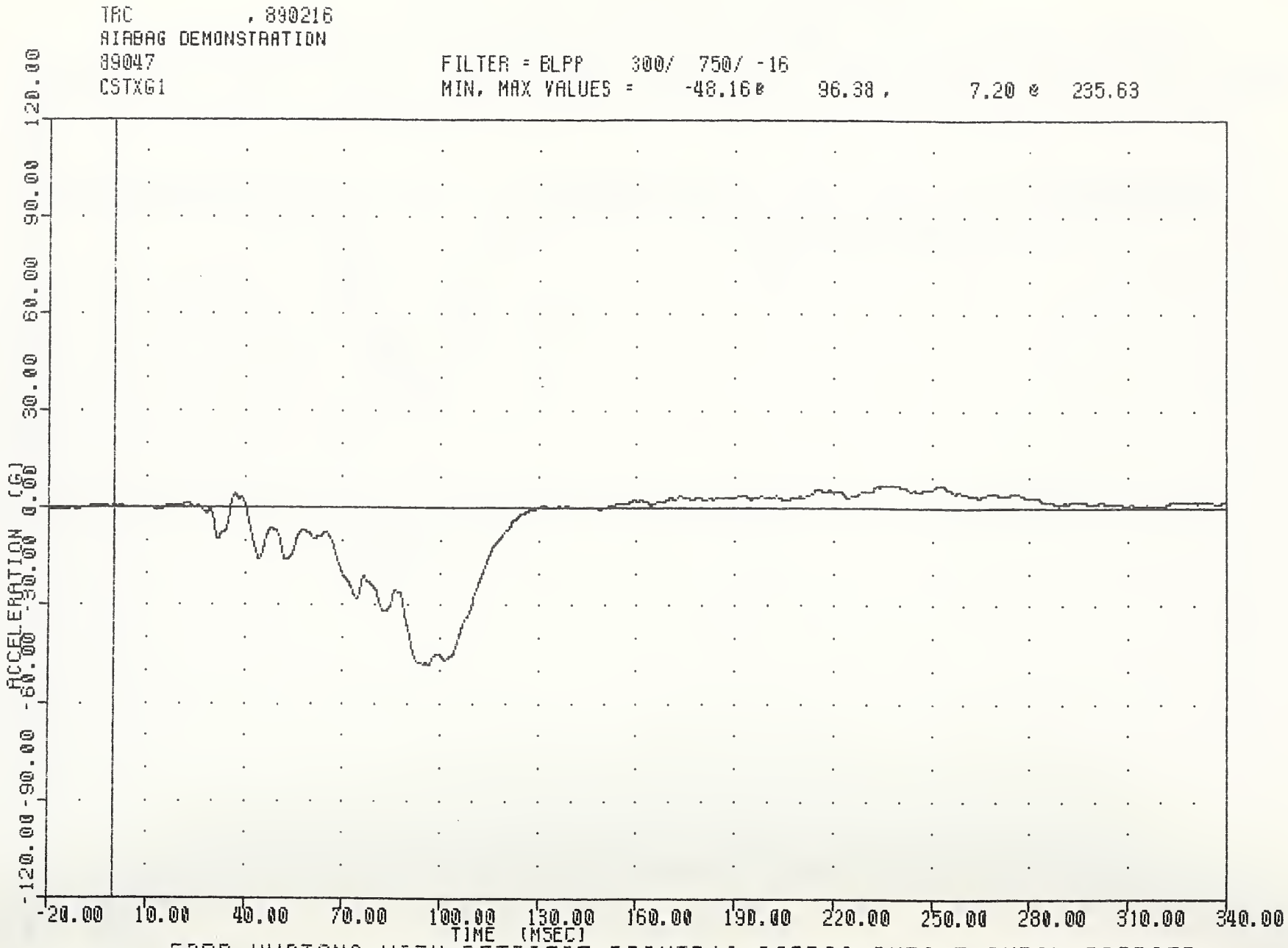
FORD MUSTANG WITH RETROFIT DRIVER'S AIRBAG INTO FRONTAL BARRIER
DRIVER HEAD Y AXIS ACCELERATION



FORD MUSTANG WITH RETROFIT DRIVER'S AIRBAG INTO FRONTAL BARRIER
DRIVER HEAD Z AXIS ACCELERATION



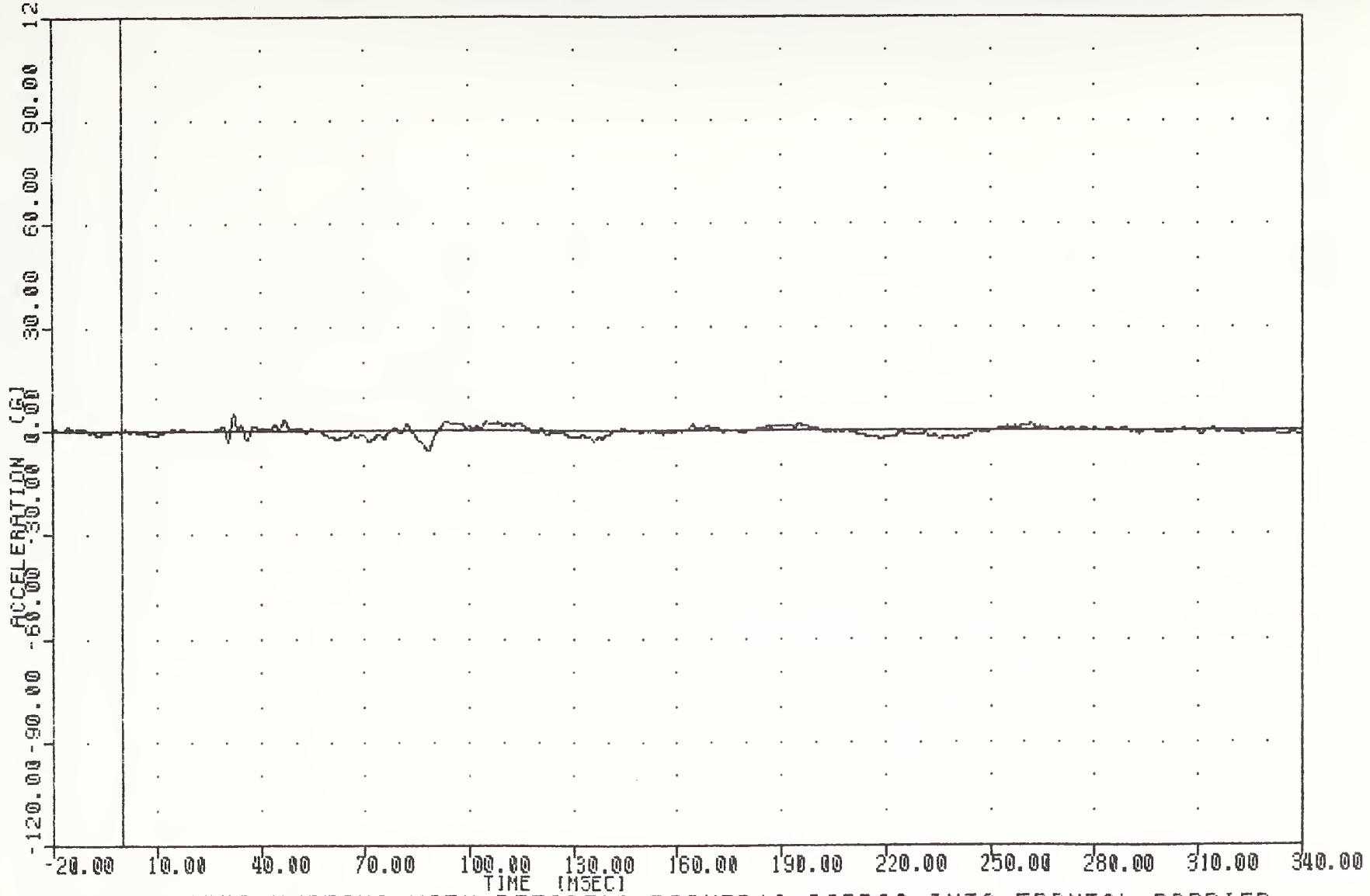
FORD MUSTANG WITH RETROFIT DRIVER'S AIRBAG INTO FRONTAL BARRIER
DRIVER HEAD RESULTANT ACCELERATION



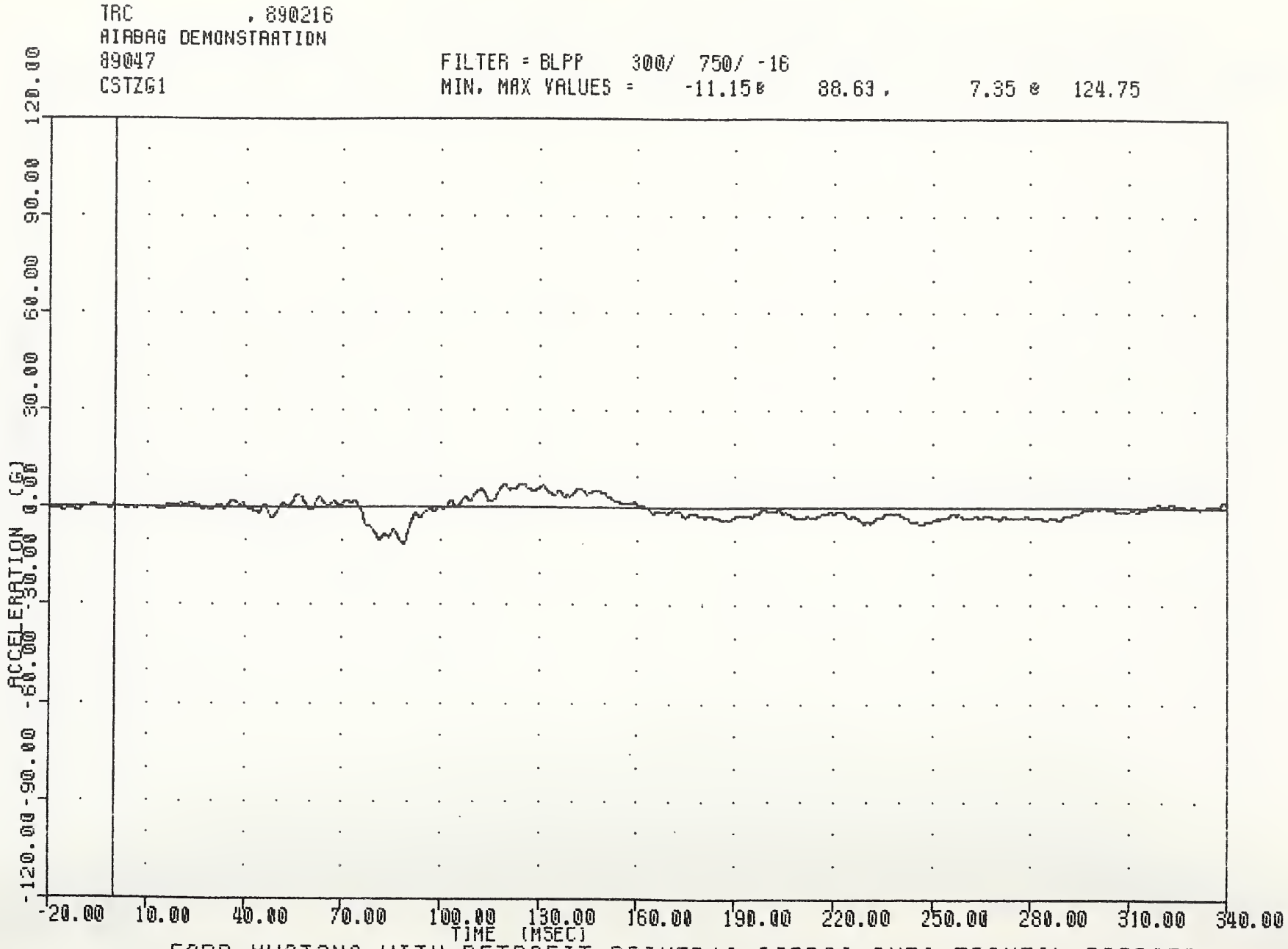
FORD MUSTANG WITH RETROFIT DRIVER'S AIRBAG INTO FRONTAL BARRIER
DRIVER CHEST X AXIS ACCELERATION

TRC , 890216
AIRBAG DEMONSTRATION
89047
CSTYG1

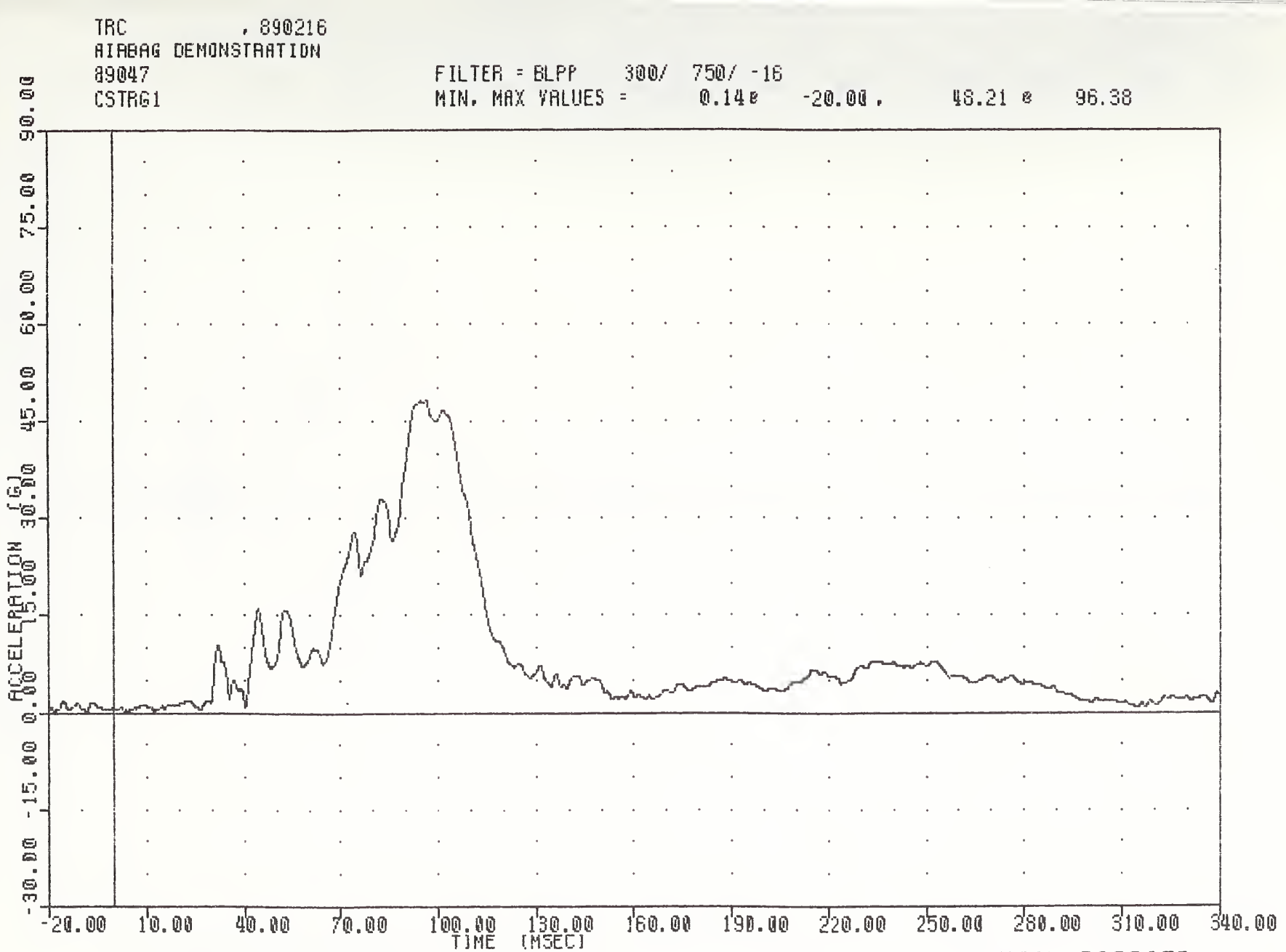
FILTER = BLPF 300/ 750/ -16
MIN. MAX VALUES = -5.86 @ 88.25 , 5.05 @ 32.25



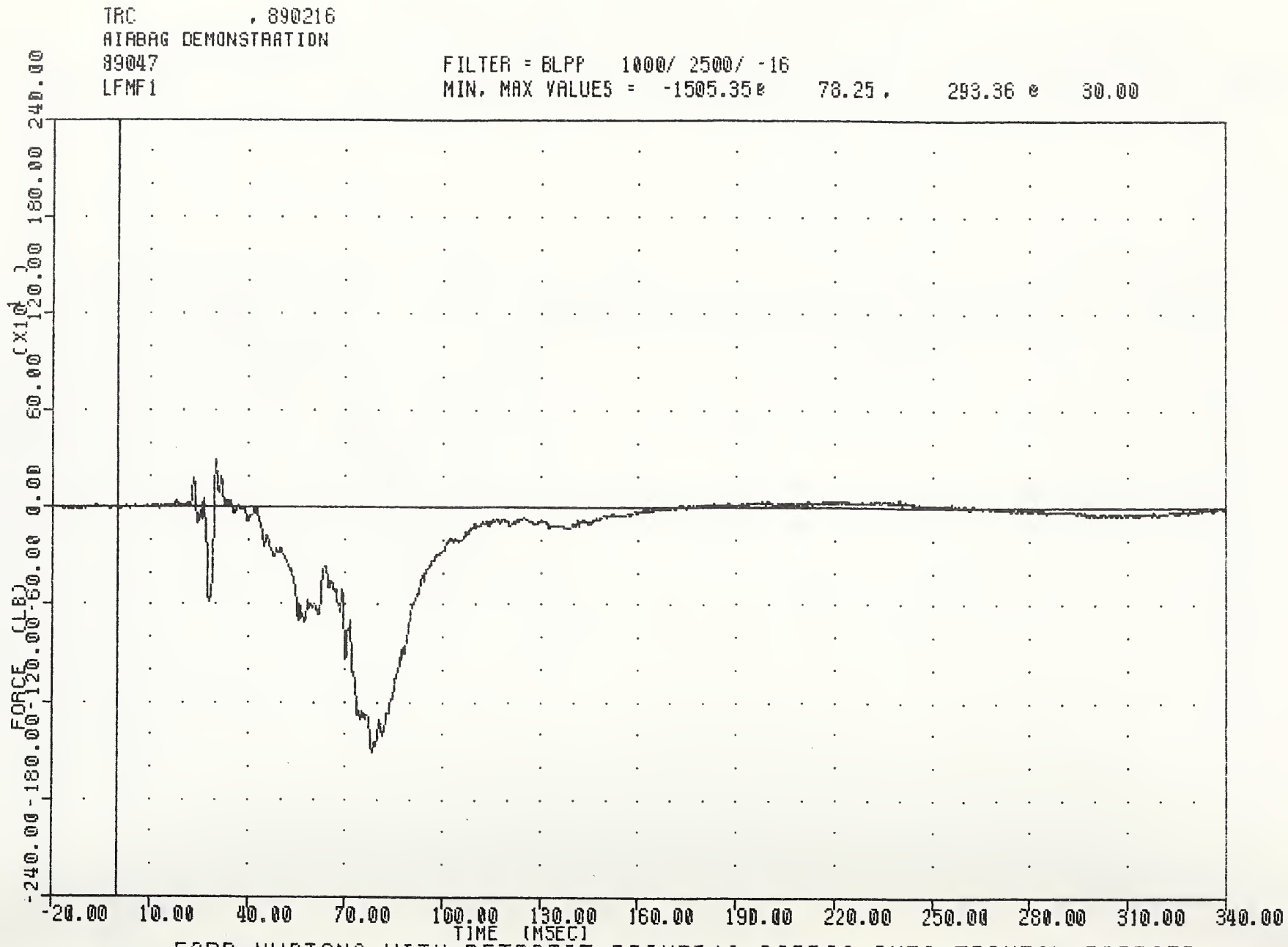
FORD MUSTANG WITH RETROFIT DRIVER'S AIRBAG INTO FRONTAL BARRIER
DRIVER CHEST Y AXIS ACCELERATION



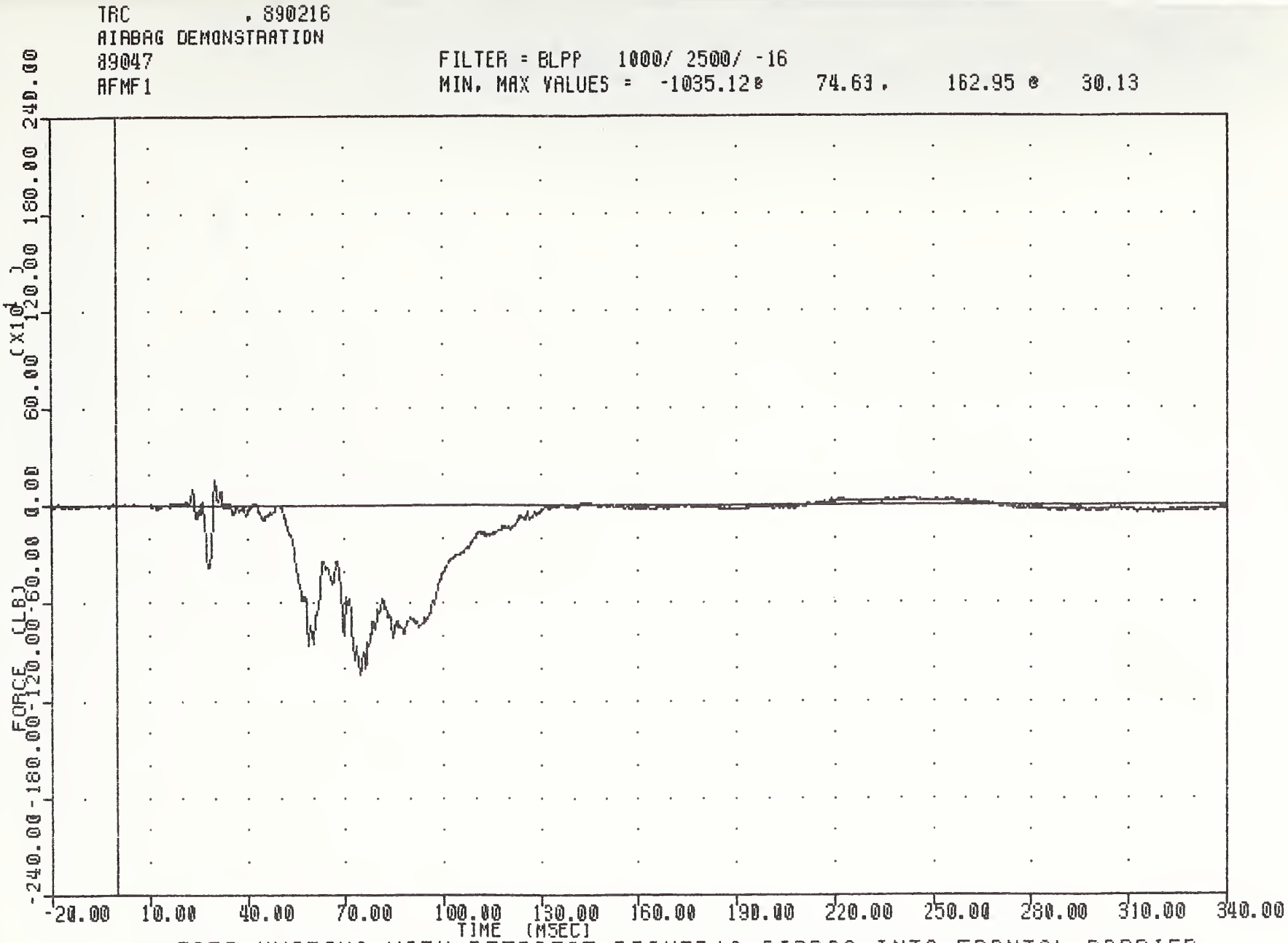
FORD MUSTANG WITH RETROFIT DRIVER'S AIRBAG INTO FRONTAL BARRIER
DRIVER CHEST Z AXIS ACCELERATION



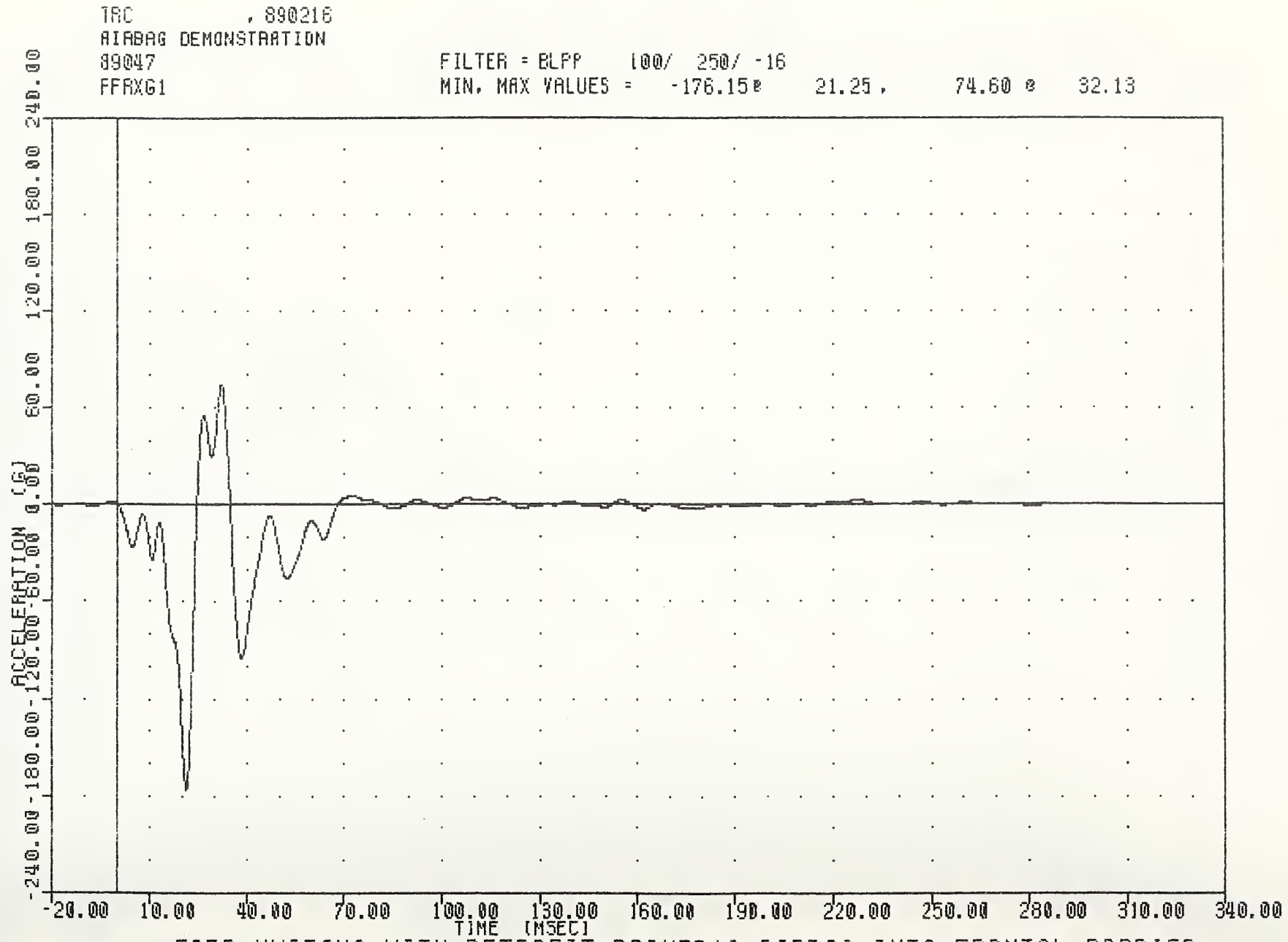
FORD MUSTANG WITH RETROFIT DRIVER'S AIRBAG INTO FRONTAL BARRIER
DRIVER CHEST RESULTANT ACCELERATION



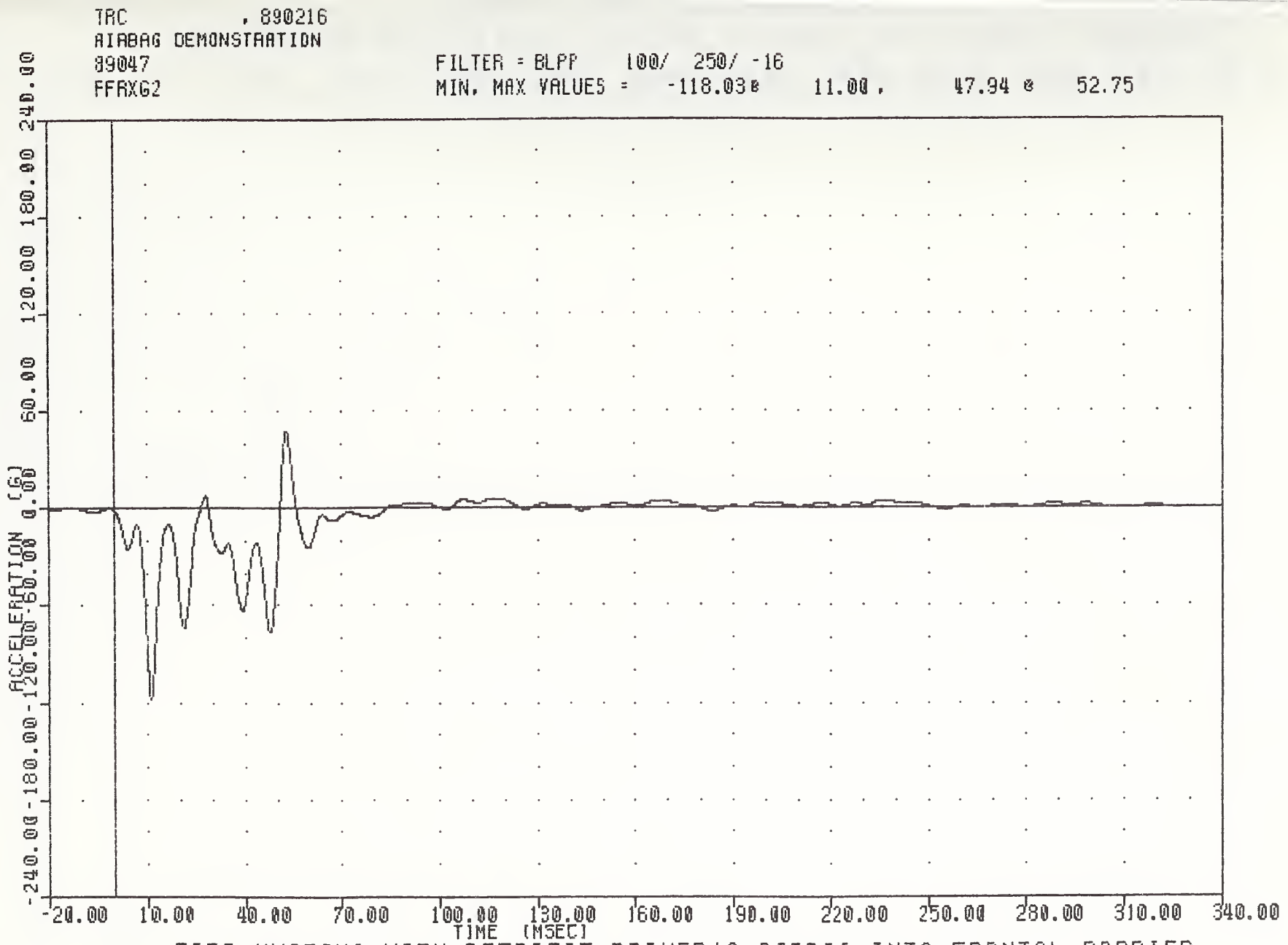
FORD MUSTANG WITH RETROFIT DRIVER'S AIRBAG INTO FRONTAL BARRIER
DRIVER LEFT FEMUR FORCE



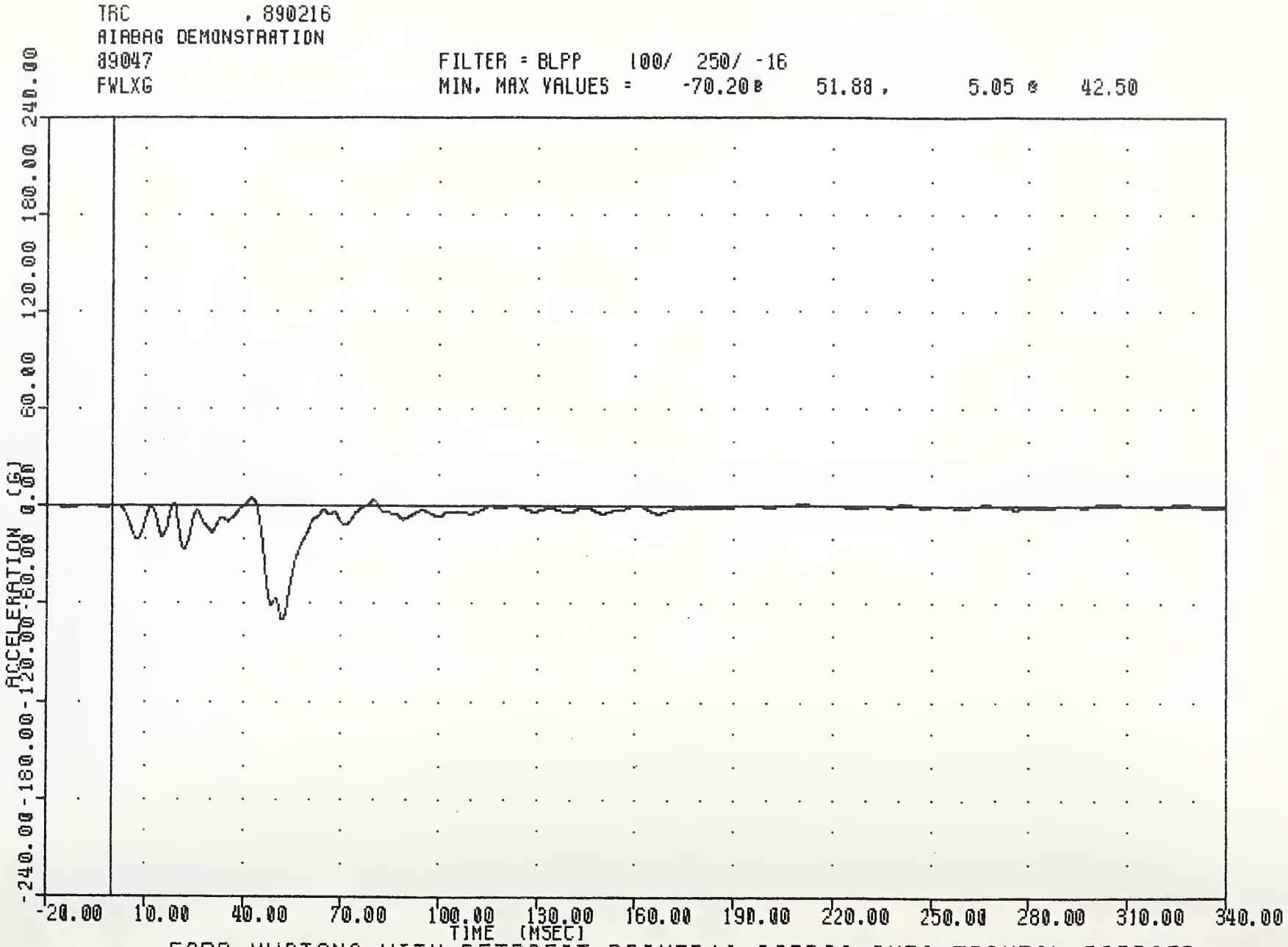
FORD MUSTANG WITH RETROFIT DRIVER'S AIRBAG INTO FRONTAL BARRIER
DRIVER RIGHT FEMUR FORCE



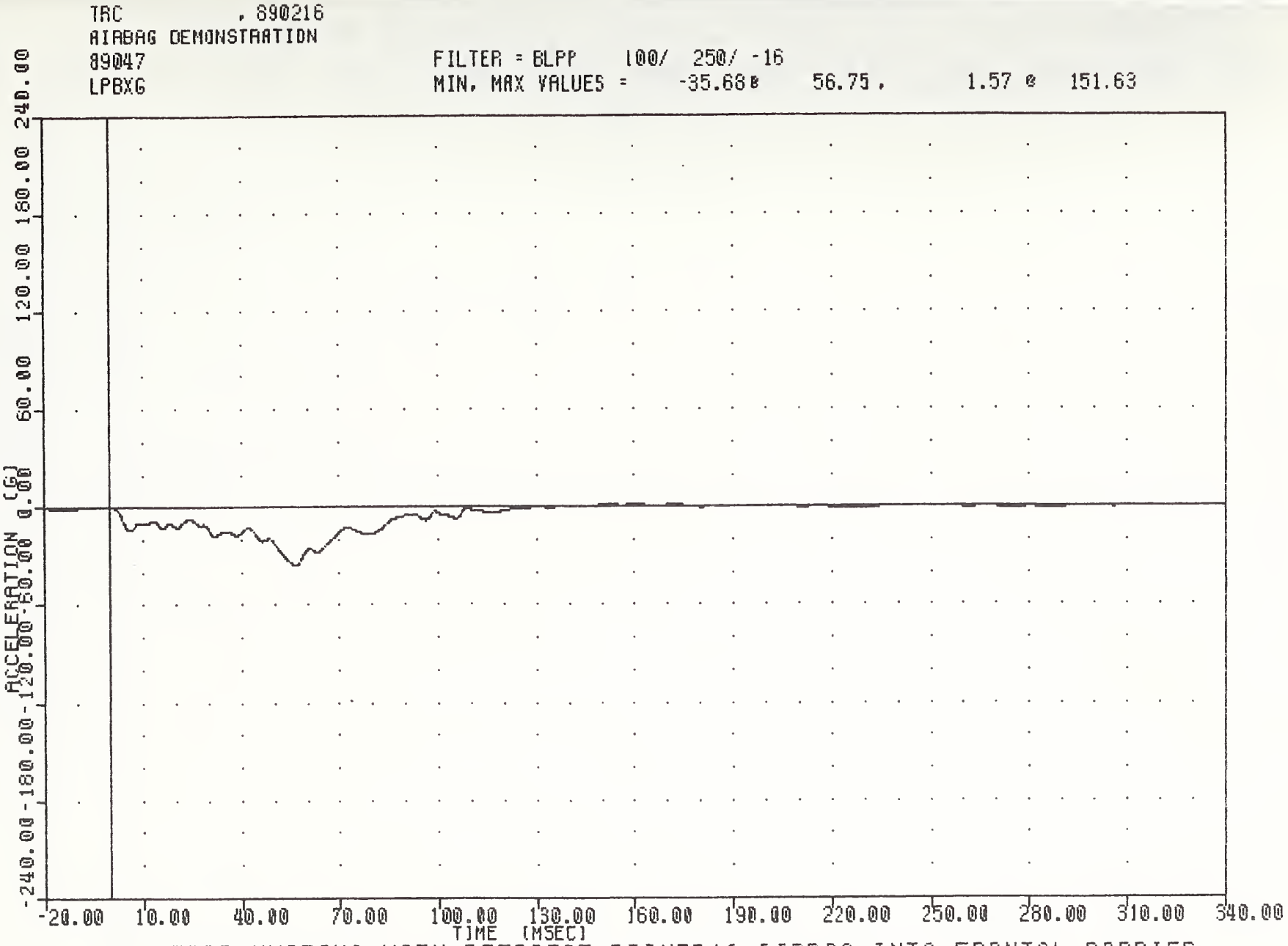
FORD MUSTANG WITH RETROFIT DRIVER'S AIRBAG INTO FRONTAL BARRIER
LEFT FRONT FRAME RAIL X AXIS ACCELERATION



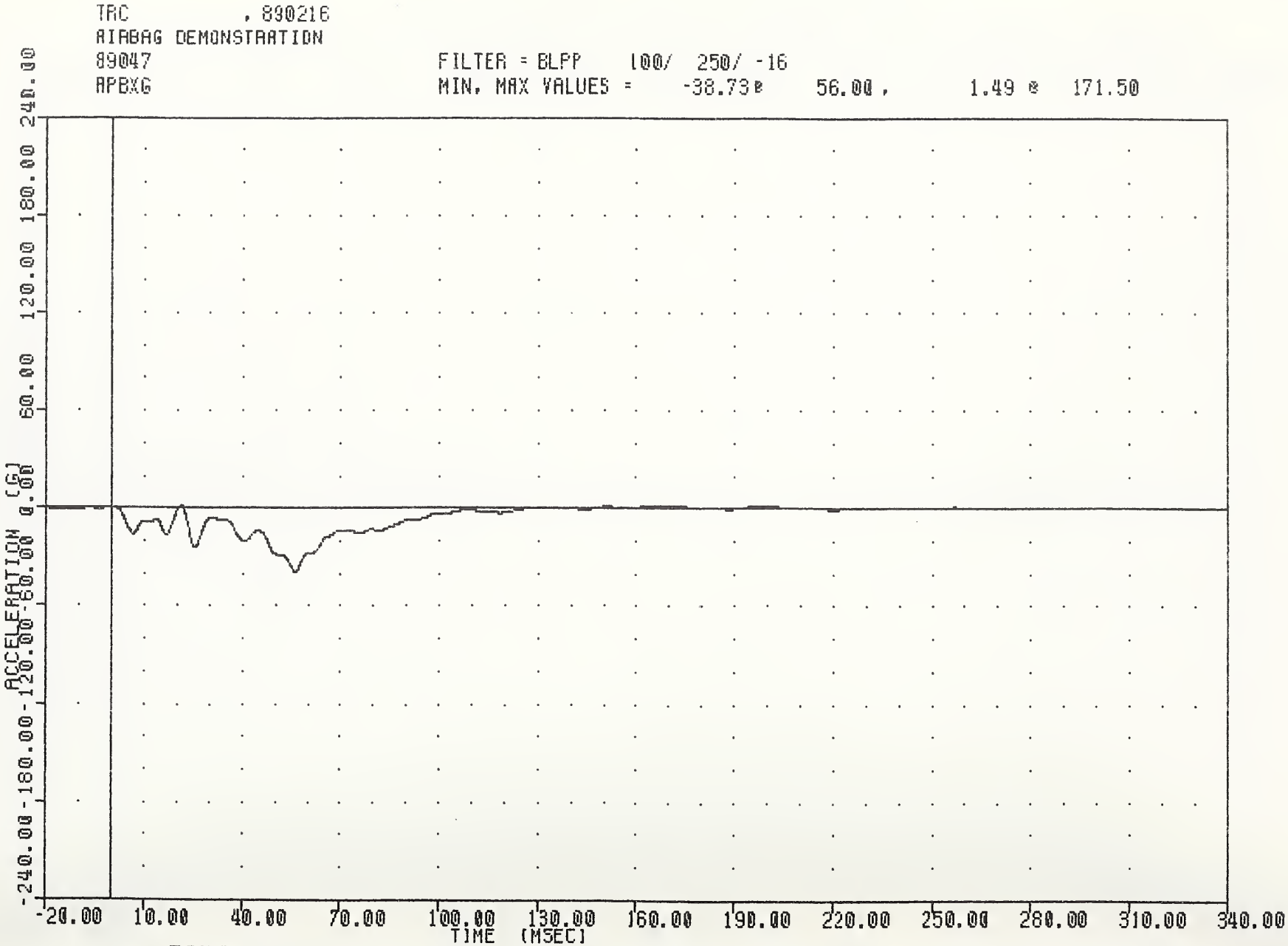
FORD MUSTANG WITH RETROFIT DRIVER'S AIRBAG INTO FRONTAL BARRIER
RIGHT FRONT FRAME RAIL X AXIS ACCELERATION



FORD MUSTANG WITH RETROFIT DRIVER'S AIRBAG INTO FRONTAL BARRIER
FIREWALL X AXIS ACCELERATION



FORD MUSTANG WITH RETROFIT DRIVER'S AIRBAG INTO FRONTAL BARRIER
LEFT B-PILLAR X AXIS ACCELERATION



FORD MUSTANG WITH RETROFIT DRIVER'S AIRBAG INTO FRONTAL BARRIER
RIGHT B-PILLAR X AXIS ACCELERATION

APPENDIX C

DUMMY CALIBRATION INFORMATION

PRE-TEST CALIBRATION

S/N: 830

TRANSPORTATION RESEARCH CENTER OF OHIO

EXTERNAL DIMENSIONS

PART 572 08-FEB-89

TEMPERATURE 70 F RELATIVE HUMIDITY 19 %
VRTC ED83018 572B SN830 EXT. DIMENSION CAL18

DESCRIPTION SN 830 ALDERSON	SPECIFICATION	TEST RESULTS
Sitting Height	35.6 - 35.8 IN	35.6 IN
Shoulder Pivot Height	21.8 - 22.4 IN	22.3 IN
Hip Pivot Height	3.9 IN (ref)	3.9 IN
Hip Pivot From Backline	4.8 IN (ref)	4.8 IN
Knee Pivot From Backline	20.1 - 20.7 IN	20.6 IN
Rear of Head From Backline	1.7 IN (ref)	1.7 IN
Chest Depth	9.1 - 9.6 IN	9.2 IN
Shoulder Width	17.8 - 18.4 IN	18.1 IN
Chest Circumference Over Nipples	36.8 - 40.0 IN	37.3 IN
Waist Circumference at Min. Girth	31.4 - 32.6 IN	32.2 IN
Hip Width	14.0 - 15.4 IN	14.6 IN
Knee Pivot From Floor	19.3 - 19.9 IN	19.4 IN

DUMMY MEETS SPECIFICATIONS

TECHNICIAN Chas Middleton

TRANSPORTATION RESEARCH CENTER OF OHIO

HEAD DROP TEST

PART 572 09-Feb-89

TEMPERATURE 71 F RELATIVE HUMIDITY 19 %
VRTC HD83018 572B SN 830 HEAD DROP CAL 18

TEST PARAMETER	SPECIFICATION	TEST RESULTS
PEAK RESULTANT ACCELERATION	210 - 260 G	246.00 G
TIME ABOVE 100 G LEVEL	0.9 - 1.5 MSEC	1.22 MSEC
PEAK LATERAL ACCELERATION	10 G MAX	-1.33 G
IS ACCELERATION CURVE UNIMODAL?		YES

DUMMY MEETS SPECIFICATIONS

TECHNICIAN Chas. Middlet

TRANSPORTATION RESEARCH CENTER OF OHIO

NECK PENDULUM TEST

PART 572 10-Feb-89

TEMPERATURE 72 F RELATIVE HUMIDITY 21 %
VRTC HN83018 572B SN 830 HEAD/NECK CAL 18

TEST PARAMETER	SPECIFICATION	TEST RESULTS
Pendulum velocity	21.5 to 25.5 ft/sec	24.74 ft/sec
Pendulum Deceleration:		
T1 - T2: 5 - 20 G	3 msec max	2.51 msec
T2 - T3: 20 - 20 G	25 - 30 msec	26.27 msec
T3 - T4: 20 - 5 G	10 msec max	8.45 msec
Avg. G level T2 - T3	20 - 24 G	22.49 G
Maximum Rotation Angle	63 - 73 deg	63.52 deg
Peak Head Resultant Accel	26 G max	24.09 G

Test Parameter	Specification		Test Results	
Rotation Angle (degrees)	Time (msec)	Chordal Disp. (in)	Time (msec)	Chordal Disp. (in)
0	-2.0 - +2.0	-0.5 - +0.5	1.25	0.03
30	25.6 - 34.4	2.1 - 3.1	30.80	2.42
60	40.3 - 51.7	4.3 - 5.3	49.39	4.66
max	53.2 - 66.8	5.0 - 6.0	58.13	4.97
60	67.0 - 83.0	4.3 - 5.3	67.33	4.66
30	85.4 - 104.6	2.1 - 3.1	87.21	2.29
0	101.0 - 123.0	-0.5 - +0.5	101.20	0.10

SND: 6.10 in

DUMMY MEETS SPECIFICATIONS

TECHNICIAN Chas. Middlet

TRANSPORTATION RESEARCH CENTER OF OHIO

THORAX IMPACT TEST

PART 572 10-Feb-89

TEMPERATURE 72 F RELATIVE HUMIDITY 21 %
VRTC TL83018 572B SN 830 L.S.THORAX CAL 18

TEST PARAMETER	LOW SPEED TEST SPECIFICATION	TEST RESULTS
PENDULUM VELOCITY	13.86-14.14 FT/SEC	14.04 FT/SEC
PEAK DEFLECTION	1.1 IN max.	0.95 IN
PEAK RESISTIVE FORCE	1,450. LB max.	1290. LB
INTERNAL HYSTERESIS	50% - 70%	67.4%

DUMMY MEETS SPECIFICATIONS

TECHNICIAN Chas. Middleton

TRANSPORTATION RESEARCH CENTER OF OHIO

THORAX IMPACT TEST

PART 572 10-Feb-89

TEMPERATURE 72 F RELATIVE HUMIDITY 21 %
VRTC TH83018 572B SN 830 H.S.THORAX CAL 18

TEST PARAMETER	HIGH SPEED TEST SPECIFICATION	TEST RESULTS
PENDULUM VELOCITY	21.78-22.22 FT/SEC	21.92 FT/SEC
PEAK DEFLECTION	1.7 IN max.	1.38 IN
PEAK RESISTIVE FORCE	2,250. LB max.	2025. LB
INTERNAL HYSTERESIS	50% - 70%	64.7%

DUMMY MEETS SPECIFICATIONS

TECHNICIAN Chas. Middleton

TRANSPORTATION RESEARCH CENTER OF OHIO

ABDOMINAL COMPRESSION TEST

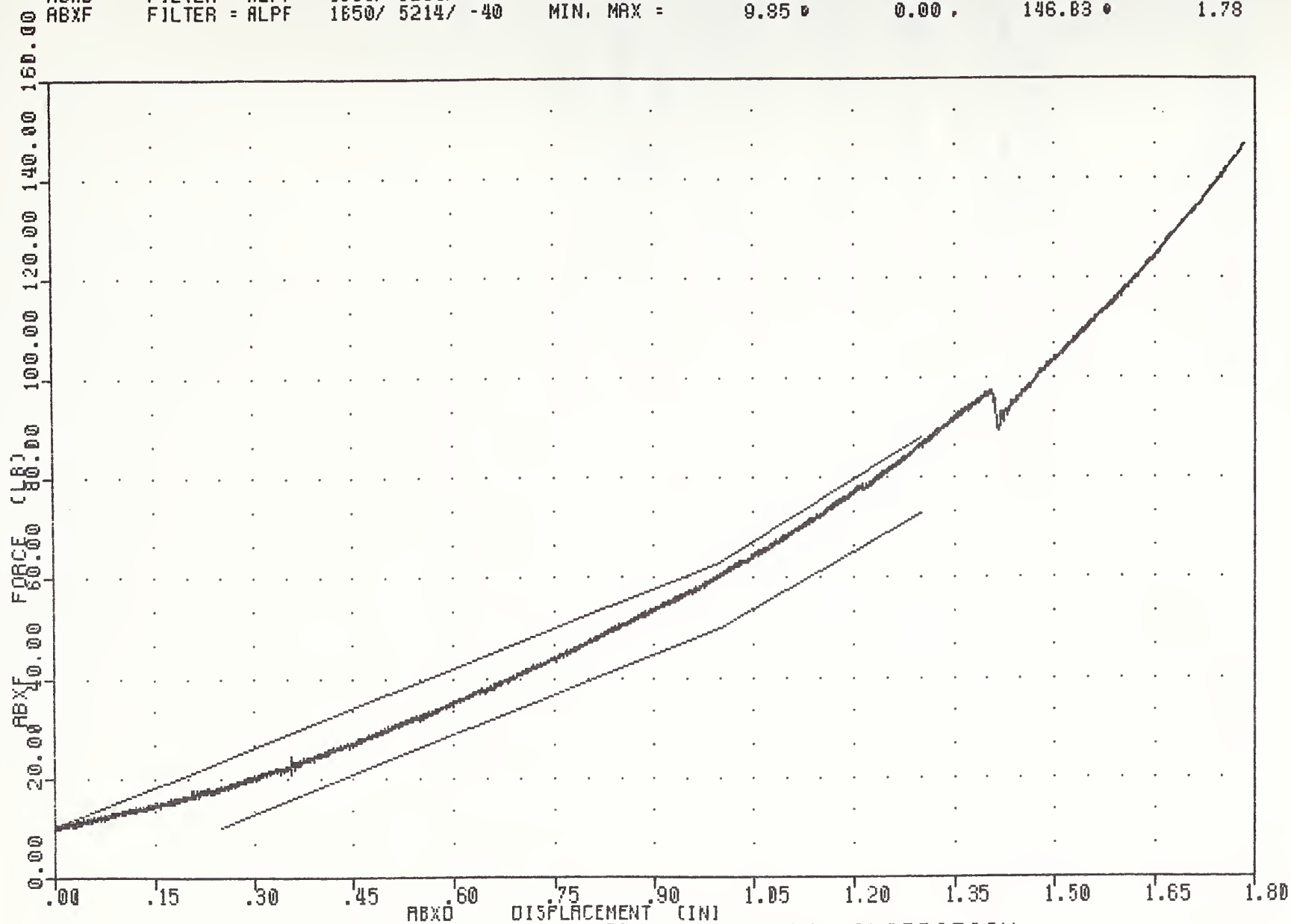
PART 572 09-Feb-89

TEMPERATURE 71 F RELATIVE HUMIDITY 19 %
VRTC AB83018 572B SN 830 ABDOM COMPR CAL 18

TEST CORRIDORS		
DISPLACEMENT	FORCE	TEST RESULTS
0.00 IN	10.00 LBS	10.00 LBS
0.50 IN	23.00 - 36.00 LBS	29.72 LBS
0.75 IN	36.00 - 50.00 LBS	43.92 LBS
1.00 IN	50.00 - 63.00 LBS	60.50 LBS
1.30 IN	73.00 - 88.00 LBS	86.54 LBS

DUMMY MEETS SPECIFICATIONS

TECHNICIAN Chas Middleton



PART 572-B HYBRID II ABDOMEN CALIBRATION
ABDOMINAL FORCE VS DISPLACEMENT

TRANSPORTATION RESEARCH CENTER OF OHIO

LUMBAR FLEXION TEST

PART 572 09-FEB-89

TEMPERATURE 69 F RELATIVE HUMIDITY 19 %
VRTC LF83018 572B SN830 LUMBAR FLEX CAL18

DEFLECTION	SPECIFICATION	TEST RESULTS
0 DEG	0 LB	0.00 LB
20 DEG	22.00 - 34.00 LB	34.00 LB
30 DEG	34.00 - 46.00 LB	44.00 LB
40 DEG	46.00 - 58.00 LB	56.00 LB
NET RETURN ANGLE	< 12 DEG	5.20 DEG

DUMMY MEETS SPECIFICATIONS

TECHNICIAN Chas. Middlet

TRANSPORTATION RESEARCH CENTER OF OHIO

KNEE IMPACT TEST

PART 572 10-Feb-89

TEMPERATURE 72 F RELATIVE HUMIDITY 21 %
LEFT KNEE
VRTC LK83018 572B SN 830 L.KNEE IMP CAL 18

TEST PARAMETER	SPECIFICATION	TEST RESULTS
PROBE VELOCITY	6.76 - 7.04 FT/SEC	6.91 FT/SEC
PEAK KNEE IMPACT FORCE	1850 - 2500 LB	2325.30 LB
DURATION ABOVE 1000 LB	>=1.7 MSEC	1.73 MSEC

DUMMY MEETS SPECIFICATIONS

TECHNICIAN Chas. Middleton

TRANSPORTATION RESEARCH CENTER OF OHIO

KNEE IMPACT TEST

PART 572 10-Feb-89

TEMPERATURE 72 F RELATIVE HUMIDITY 21 %
RIGHT KNEE
VRTC RK83018 572B SN 830 R.KNEE IMP CAL 18

TEST PARAMETER	SPECIFICATION	TEST RESULTS
PROBE VELOCITY	6.76 - 7.04 FT/SEC	6.91 FT/SEC
PEAK KNEE IMPACT FORCE	1850 - 2500 LB	1858.76 LB
DURATION ABOVE 1000 LB	>=1.7 MSEC	1.99 MSEC

DUMMY MEETS SPECIFICATIONS

TECHNICIAN Chas. Middlet

POST-TEST CALIBRATION

S/N: 830

TRANSPORTATION RESEARCH CENTER OF OHIO

EXTERNAL DIMENSIONS

PART 572 02-MAR-89

TEMPERATURE 72 F RELATIVE HUMIDITY 22 %
VRTC ED83019 572B SN830 EXT. DIMENSION CAL19

DESCRIPTION SN 830 ALDERSON	SPECIFICATION	TEST RESULTS
Sitting Height	35.6 - 35.8 IN	35.6 IN
Shoulder Pivot Height	21.8 - 22.4 IN	22.3 IN
Hip Pivot Height	3.9 IN (ref)	3.9 IN
Hip Pivot From Backline	4.8 IN (ref)	4.8 IN
Knee Pivot From Backline	20.1 - 20.7 IN	20.6 IN
Rear of Head From Backline	1.7 IN (ref)	1.7 IN
Chest Depth	9.1 - 9.6 IN	9.2 IN
Shoulder Width	17.8 - 18.4 IN	18.1 IN
Chest Circumference Over Nipples	36.8 - 40.0 IN	37.3 IN
Waist Circumference at Min. Girth	31.4 - 32.6 IN	32.2 IN
Hip Width	14.0 - 15.4 IN	14.6 IN
Knee Pivot From Floor	19.3 - 19.9 IN	19.4 IN

DUMMY MEETS SPECIFICATIONS

TECHNICIAN Chas. Middlet

TRANSPORTATION RESEARCH CENTER OF OHIO

HEAD DROP TEST

PART 572 02-Mar-89

TEMPERATURE 72 F RELATIVE HUMIDITY 22 %
VRTC HD83019 572B SN 830 HEAD DROP CAL 19

TEST PARAMETER	SPECIFICATION	TEST RESULTS
PEAK RESULTANT ACCELERATION	210 - 260 G	223.15 G
TIME ABOVE 100 G LEVEL	0.9 - 1.5 MSEC	1.25 MSEC
PEAK LATERAL ACCELERATION	10 G MAX	-3.42 G
IS ACCELERATION CURVE UNIMODAL?		YES

DUMMY MEETS SPECIFICATIONS

TECHNICIAN Chas. Middlet

TRANSPORTATION RESEARCH CENTER OF OHIO

NECK PENDULUM TEST

PART 572 03-Mar-89

TEMPERATURE 72 F RELATIVE HUMIDITY 27 %
VRTC HN83019 572B SN 830 HEAD/NECK CAL 19

TEST PARAMETER	SPECIFICATION	TEST RESULTS
Pendulum velocity	21.5 to 25.5 ft/sec	25.00 ft/sec
Pendulum Deceleration:		
T1 - T2: 5 - 20 G	3 msec max	2.54 msec
T2 - T3: 20 - 20 G	25 - 30 msec	26.57 msec
T3 - T4: 20 - 5 G	10 msec max	7.56 msec
Avg. G level T2 - T3	20 - 24 G	23.47 G
Maximum Rotation Angle	63 - 73 deg	64.05 deg
Peak Head Resultant Accel	26 G max	24.54 G

Test Parameter	Specification		Test Results	
Rotation Angle (degrees)	Time (msec)	Chordal Disp. (in)	Time (msec)	Chordal Disp. (in)
0	-2.0 - +2.0	-0.5 - +0.5	0.63	0.00
30	25.6 - 34.4	2.1 - 3.1	30.82	2.48
60	40.3 - 51.7	4.3 - 5.3	48.58	4.70
max	53.2 - 66.8	5.0 - 6.0	59.50	5.03
60	67.0 - 83.0	4.3 - 5.3	67.72	4.70
30	85.4 - 104.6	2.1 - 3.1	86.93	2.33
0	101.0 - 123.0	-0.5 - +0.5	101.03	0.09

SND: 6.10 in

DUMMY MEETS SPECIFICATIONS

TECHNICIAN Chas. Middlet

TRANSPORTATION RESEARCH CENTER OF OHIO

THORAX IMPACT TEST

PART 572 06-Mar-89

TEMPERATURE 70 F RELATIVE HUMIDITY 30 %
VRTC TL83019 572B SN 830 L.S.THORAX CAL 19

TEST PARAMETER	LOW SPEED TEST SPECIFICATION	TEST RESULTS
PENDULUM VELOCITY	13.86-14.14 FT/SEC	14.04 FT/SEC
PEAK DEFLECTION	1.1 IN max.	0.91 IN
PEAK RESISTIVE FORCE	1,450. LB max.	1354. LB
INTERNAL HYSTERESIS	50% - 70%	68.0%

DUMMY MEETS SPECIFICATIONS

TECHNICIAN Chas. Middlet

TRANSPORTATION RESEARCH CENTER OF OHIO

THORAX IMPACT TEST

PART 572 06-Mar-89

TEMPERATURE 69 F RELATIVE HUMIDITY 29 %
VRTC TH83019 572B SN 830 H.S.THORAX CAL 19

TEST PARAMETER	HIGH SPEED TEST SPECIFICATION	TEST RESULTS
PENDULUM VELOCITY	21.78-22.22 FT/SEC	21.92 FT/SEC
PEAK DEFLECTION	1.7 IN max.	1.33 IN
PEAK RESISTIVE FORCE	2,250. LB max.	2101. LB
INTERNAL HYSTERESIS	50% - 70%	66.7%

DUMMY MEETS SPECIFICATIONS

TECHNICIAN Chas. Middlet

TRANSPORTATION RESEARCH CENTER OF OHIO

ABDOMINAL COMPRESSION TEST

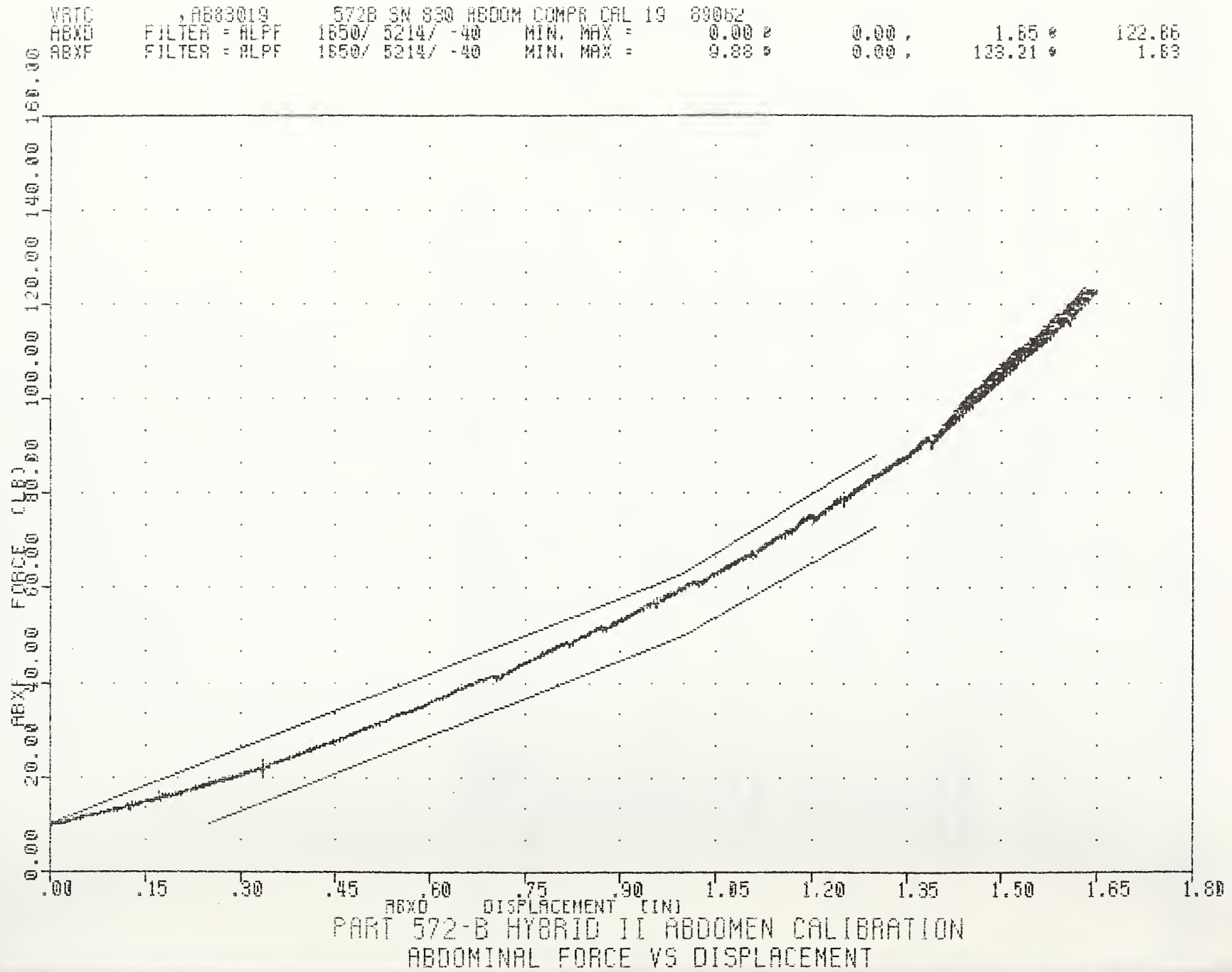
PART 572 03-Mar-89

TEMPERATURE 72 F RELATIVE HUMIDITY 25 %
VRTC AB83019 572B SN 830 ABDOM COMPR CAL 19

TEST CORRIDORS		
DISPLACEMENT	FORCE	TEST RESULTS
0.00 IN	10.00 LBS	10.00 LBS
0.50 IN	23.00 - 36.00 LBS	30.42 LBS
0.75 IN	36.00 - 50.00 LBS	44.02 LBS
1.00 IN	50.00 - 63.00 LBS	60.40 LBS
1.30 IN	73.00 - 88.00 LBS	83.03 LBS

DUMMY MEETS SPECIFICATIONS

TECHNICIAN Chas. Middlet



PART 572-B HYBRID II ABDOMEN CALIBRATION

ABDOMINAL FORCE VS DISPLACEMENT

TRANSPORTATION RESEARCH CENTER OF OHIO

LUMBAR FLEXION TEST

PART 572 02-MAR-89

TEMPERATURE 72 F RELATIVE HUMIDITY 22 %
VRTC LF83019 572B SN830 LUMBAR FLEX CAL19

DEFLECTION	SPECIFICATION	TEST RESULTS
0 DEG	0 LB	0.00 LB
20 DEG	22.00 - 34.00 LB	32.00 LB
30 DEG	34.00 - 46.00 LB	41.00 LB
40 DEG	46.00 - 58.00 LB	56.00 LB
NET RETURN ANGLE	< 12 DEG	6.36 DEG

DUMMY MEETS SPECIFICATIONS

TECHNICIAN Chas. Middleton

TRANSPORTATION RESEARCH CENTER OF OHIO

KNEE IMPACT TEST

PART 572 06-Mar-89

TEMPERATURE 71 F RELATIVE HUMIDITY 28 %
LEFT KNEE
VRTC LK83019 572B SN 830 L.KNEE IMP CAL 19

TEST PARAMETER	SPECIFICATION	TEST RESULTS
PROBE VELOCITY	6.76 - 7.04 FT/SEC	6.88 FT/SEC
PEAK KNEE IMPACT FORCE	1850 - 2500 LB	1951.85 LB
DURATION ABOVE 1000 LB	>=1.7 MSEC	1.72 MSEC

DUMMY MEETS SPECIFICATIONS

TECHNICIAN Chas. Middlet

TRANSPORTATION RESEARCH CENTER OF OHIO

KNEE IMPACT TEST

PART 572 06-Mar-89

TEMPERATURE 70 F RELATIVE HUMIDITY 29 %
RIGHT KNEE
VRTC RK83019 572B SN 830 R.KNEE IMP CAL 19

TEST PARAMETER	SPECIFICATION	TEST RESULTS
PROBE VELOCITY	6.76 - 7.04 FT/SEC	6.88 FT/SEC
PEAK KNEE IMPACT FORCE	1850 - 2500 LB	1946.42 LB
DURATION ABOVE 1000 LB	>=1.7 MSEC	1.85 MSEC

DUMMY MEETS SPECIFICATIONS

TECHNICIAN Chas. Middlet

APPENDIX D

MISCELLANEOUS TEST INFORMATION

DUMMY INSTRUMENTATION PLACEMENT

DUMMY MANUFACTURER & S/N: ALDERSON RESEARCH LABS #830

SEATING POSITION: DRIVER

LOCATION	AXIS	MFR	MODEL	S/N	ORIENTATION (+ SENSING)
HEAD ACCELERATION	X	ENDEVCO	7264	AL42	REAR
HEAD ACCELERATION	Y	ENDEVCO	7264	AJ03	LEFT
HEAD ACCELERATION	Z	ENDEVCO	7264	AP45	UP
CHEST ACCELERATION	X	ENDEVCO	7264	AJ11	FRONT
CHEST ACCELERATION	Y	ENDEVCO	7264	AL40	RIGHT
CHEST ACCELERATION	Z	ENDEVCO	7264	AN09	UP
LEFT FEMUR FORCE		GSE	2430	717	TENSION
RIGHT FEMUR FORCE		GSE	2430	739	TENSION

VEHICLE INSTRUMENTATION PLACEMENT

NO.	LOCATION	AXIS	MFR	MODEL	S/N	ORIENTATION (+ SENSING)
1	LEFT FRAME RAIL	X	ENDEVCO	2264	AR20	REAR
2	RIGHT FRAME RAIL	X	ENDEVCO	2264	AE42	REAR
3	FIREWALL	X	ENDEVCO	2264	AJ46	FRONT
4	LEFT B-PILLAR	X	ENDEVCO	7264	BY08J	FRONT
5	RIGHT B-PILLAR	X	ENDEVCO	7264	BP34J	FRONT

SIGN CONVENTION

ALL DUMMY AND VEHICLE CHANNELS:

+X: FORWARD

+Y: LEFTWARD

+Z: UPWARD

+FORCE: TENSION

FILTERING DATA

SAE J211b

Vehicle Structural Accelerations Class 60

Occupant

Head Accelerometer Class 1000

Chest Accelerometer Class 180

Chest Deflection Class 180

Femur Force Class 600

Pelvis Accelerometer Class 180

Lower Leg Class 600

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